SCIENCE TEACHER'S WORLD

Teacher's edition of SCIENCE WORLD October 21, 1959

Using *Science World* in Your Teaching

Secrets of the Sun (pp. 5-8)

General Science Topic: Our sun
Physics Topics: Nucleonics, nature of light

About This Article

The author describes the nuclear activity in the sun which gives rise to its enormous energy and to several awesome phenomena that have been traced to this nuclear activity—phenomena such as solar flares, the solar corona, sunspots, auroras, magnetic storms and the like. These phenomena are vividly depicted, and the methods used to study them are described. The article then indicates some of the more recent developments in the technology of directly utilizing solar energy. Some of these developments are shown graphically in the illustrations accompanying the article.

Topics for Discussion

1. The temperatures of the sun.
2. The source of the sun's energy.
3. What the spectroscope reveals about the sun.
4. The photosphere, chromosphere, and corona.
5. The history and significance of sunspots.
6. Explanations of auroras and the Van Allen belts of radiation.
7. Instruments used to study the sun.
8. New ways of harnessing solar energy.

You may find it effective to suggest that students select one of the above topics as the subject of a composition to be written from information gained in the article. The better compositions might then be read to the class and discussed.

Trash That Scientists Treasure (pp. 9-12)

Biology Topic: Evolution of man and his cultures

About This Article

Many high school biology courses culminate in a unit on the history of man on earth. This article will contribute significantly to the study of such a unit. Moreover, it will open up to the student a fascinating field of study that straddles the biological, physical, and social sciences.

By using as an example a specific excavation—that of the Cienega Creek site in Arizona—the author exposes the student not only to the history of a culture, but also to the methods and reasoning of archaeologists as they reconstruct such a history.

The remains of what a community discarded or left behind over centuries are found in the form of a mound. The mound consists of layers of "trash." The oldest layer is usually, but not always, at the bottom. The archaeologist, at work, cuts vertical faces into the mound like slices off a layer-cake. He reads the layers in each slice like a book—he reads about climatic changes that have taken place in remote times; he reads about such profound cultural changes as an economy based upon hunting and seed gathering giving way to an economy based on agriculture.

This "reading" involves more than mere observation—charcoal specimens must be dated in the laboratory; some salvaged material, such as basketry found in a state of partial disintegration, must be chemically treated before it can be handled without falling apart. The color, texture, and other characteristics of each layer of soil must be carefully studied.

By studies such as these the excavations at Cienega Creek have yielded a history of the area that goes back to several thousand years, B. C.

Topics for Class Discussion

1. List specifically the kinds of artifacts contained in mounds.
2. Describe some ways in which communities have used ancient mounds.
3. Describe the plan used by archaeologists in excavating the mound at Cienega Creek.
4. What cultures in the Southwest have been found by archaeologists to be historically linked?
5. How do laboratory studies come to be necessary for the archaeologist?
6. How are excavated baskets treated before they can be handled for study?
7. What radical changes did Cochise culture undergo in ancient times?
8. Explain this statement: "An archaeological site is like the last surviving copy of a history book."

Man Who Made Elements (p. 20)

Physics Topic: Nucleonics
Chemistry Topic: The periodic table, transmutation

About This Article

The article tells the story of the discovery of the transuranium elements, beginning with the attempts of Fermi and Segre to effect neutron-capture by uranium atoms, and culminating in the "production of the elements americium—95—through Mendelevium—101." The article will afford the teacher an opportunity to emphasize the dependence of discovery on technological refinements (cyclotrons, etc.) and, above all, on refinement in theory (periodic table). Seaborg, through a quotation, describes the suspense and excitement of the discovery of the elusive and transitory element 101.

Ear on the Universe (p. 16)

General Science Topic: New instruments for exploring our universe
Physics Topic: Electromagnetic transmission and reception

About This Article

With the identification in 1932 by Karl Jansky of radio waves from outer

SCIENCE WORLD

CTOBER 21, 1959 • VOLUME 6 • NUMBER 4 • A SCHOLASTIC MAGAZIN

SECRETS of the SUN

SEE PAGE 5

SCIENCE WORLD, published fortnightly, 16 times during the school year September through May. Second-class mail privileges authorized at D...
Magazines, Inc. SUBSCRIPTION PRICES: $1.50 a school year each...

SCIENCE WORLD

OCTOBER 21, 1959 · VOLUME 6 · NUMBER 4 · A SCHOLASTIC MAGAZINE

Published with the official cooperation of the National Science Teachers Association

SCIENCE WORLD, published fortnightly, 16 times during the school year September through May. Second-class mail privileges authorized at Dayton, Ohio. Contents copyright, 1959, by Scholastic Magazines, Inc. SUBSCRIPTION PRICES: $1.50 a school year each, or $1.00 a semester each. Single subscription, Teacher's Edition, $2.00 a school year. Single copy, 15 cents. Office of Publication, McCall St., Dayton 1, Ohio. General and Editorial Offices, SCIENCE WORLD, 33 West 42nd St., New York 36, N. Y. 447

C O N T E N T S

Science in Quotes

Man masters nature not by force but by understanding. This is why science has succeeded where magic failed: because it has looked for no spell to cast on nature. The alchemist and the magician in the Middle Ages thought, and the addict of comic strips is still encouraged to think, that nature must be mastered by a device which outrages her laws. But in four hundred years since the Scientific Revolution we have learned that we gain our ends only *with* the laws of nature; we control her only by understanding her laws. We cannot even bully nature by an insistence that our work shall be designed to give power over her. We must be content that power is the by-product of understanding.

—J. BRONOWSKI

Letters

Hiccups

Dear Editor:

What makes you hiccup?

Jo Ann Kalmback
Rt. 3, Box 1188
Sacramento, California

Answer: Irritation of your stomach or the phrenic nerve (located in the diaphragm) may cause a sudden shortening of your diaphragm. This, in turn, causes a quick breath of air to be inhaled. Sudden closing of the glottis (opening between the vocal cords) follows, and the result is the sound *Hic!*

Is Lunik Really on Moon?

Dear Editor:

Is there any proof that Lunik really hit the moon? It was impossible to track it by telescope.

Anthony Cornachio
Chaminade High School
Long Island, New York

Answer: We cannot use direct observation to prove the Russian rocket is on the moon. Lunik's radio waves, picked up by the radio telescope center at Jodrell Bank in England, verified Russian reports of its progress. As the rocket moved closer to the moon's center of gravity, it picked up speed, exactly as predicted.

Scientists at Jodrell Bank said the signals stopped at the instant Lunik hit the moon. An account of how radio telescopes work is found on page 16 of this issue.

Harnessing the Tides

Dear Editor:

Why don't we harness the tides of the seas to produce hydroelectric power?

Laura Johnson
Jamaica High School
Jamaica, Long Island

Answer: Man has long tried to harness the ceaseless ebb and flow of the oceans' tides, to spin turbines and generate electricity. But we have never been able to construct a successful tidal power plant.

A tidal power project was started in 1935 at Passamaquoddy, Maine, to harness the tides of Passamaquoddy Bay. The Bay lies on both sides of the U.S.-Canadian boundary and is an arm of the Bay of Fundy. The greatest tidal ranges in the world, up to 70 feet, are at Fundy. In 'Quoddy Bay, itself, the tides average 18 feet.

The 'Quoddy project was abandoned a year after it was started. Opponents charged that the money could be better used to build conventional steam powered plants. They claimed these could furnish several times the tidal power capacity for the same money.

Last week after three years of study, a board of American and Canadian engineers reported that an expenditure of more than $500,000,000 to generate electricity from the Passamaquoddy tides would be economically sound.

The engineers stated, however, that in order to get maximum power benefits the project would have to be combined with a hydroelectric auxiliary. This would be situated at the Rankin Rapids on the Upper St. John River in Maine. The total power output of the 'Quoddy-Rankin Rapids combination could be used by Maine and the Canadian province of New Brunswick.

Water Scorpion's Snorkel

Dear Editor:

What is the function of the respiratory tube in the water scorpion?

George Hamilton
San Francisco, Calif.

Answer: The slender respiratory tube is located at the rear end of the abdomen. It may be nearly as long as the rest of the scorpion's body. When the water scorpion is suspended from the surface film of the water, the respiratory tube projects into the air. The device is similar to a snorkel tube.

Sonic Boom

Dear Editor:

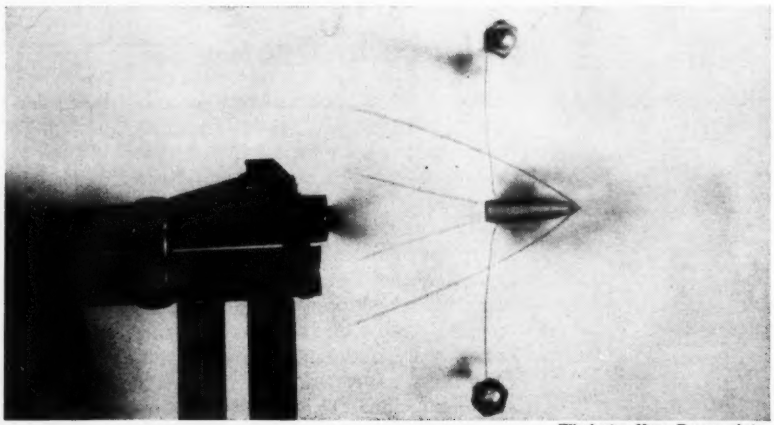
I have heard the expression "sonic boom" used. Please explain this term.

Bob Fineman
Chicago, Ill.

Answer: When an airplane flies below the speed of sound (1090 feet per second at sea level at 32 degrees F.), air flows smoothly over the wings, giving them lifting power. At the speed of sound (and faster), the air no longer acts in this manner. Shock waves of compressed particles of air appear for some distance ahead of the plane, like snow shoved ahead of a snowplow. These waves speed away from the plane at a sharp angle.

When a jet goes into a dive at supersonic speed, as many as five or six shock waves may form, all moving at the same speed as the plane. When the pilot pulls out of his dive, the shock waves continue earthward. The weaker waves are absorbed by the stronger ones. Finally one or two large waves remain. When these waves strike the ground they are heard as explosions, or sonic booms. The shock waves may sometimes be powerful enough to damage buildings.

The air in front of a speeding bullet is compressed in the same way, and thrown off to the sides. This is shown in the photo at the left, taken with a high speed camera that was triggered when the wire snapped.



Winchester News Bureau photo

Lines superimposed on high speed photo show how shock waves speed from bullet.

Scientists have devised delicate instruments to probe the . . .

SECRETS of the SUN

By ELIOT TOZER

U. S. Navy photo

Shimmering corona appears at beginning of total eclipse. Next total eclipse will sweep across Alaska in July 1963.

EARLY this month groups of excited scientists from Britain, Germany, the Netherlands, Spain, and the U. S. hurried to the Canary Islands, lugging with them huge crates containing unusual telescopes, special cameras, and photoelectric cells. With extreme care, they aimed their instruments toward a predetermined spot in the sky and began an anxious wait for Zero Hour.

They had traveled thousands of miles and spent thousands of dollars to catch a tantalizingly brief glimpse —160 seconds—of the sun.

Of course, it was a special 160 seconds. The sun was, as you know, totally eclipsed by the moon on October 2. That is, the moon completely covered the sun's face. With the intense light of the disc blacked out, the scientists on the Canary Islands were able to see once again the sun's corona, the turbulent cloud of gas that envelops it in much the same way our atmosphere blankets the Earth.

By mapping the "streamers" of electrically charged particles that flow from the corona (some reach the Earth), and by studying the whirlwinds of intense heat (perhaps 190,000,000 degrees F.) that move through it, the scientists hoped to discover the inner secrets of the sun.

Our Nearest Star

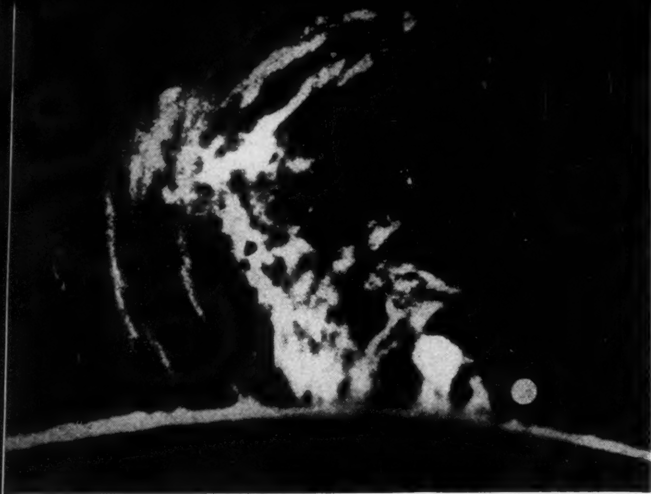
The sun is our nearest star. Only a trifling 93,000,000 miles away, it can be probed by camera and spectroscope with comparative ease. Other stars, twinkling coldly in the far, far distance, are much more difficult to study.

More important, the sun is the Earth's powerhouse. Its radiant energy warms the Earth at the equator, making the air above it rise. As the air flows toward the cooler poles, it is diverted into patterns of wind that bring us—or withhold from us—rain and snow.

The heat from this nearest star "powers" the oceans, for warm water rises and cooler water sinks, to create our ocean currents. And it evaporates millions of gallons of sea water each day. Both processes profoundly affect our weather, our health, and the growth of our crops.

Clouds of corpuscles (positive hydrogen nuclei) and free electrons sometimes speed toward us at 900 miles per second from violently boiling flares on the sun's surface. They wrap the Earth in a blanket of charged particles that light up our northern skies and disrupt long-distance radio communication. During such a magnetic "storm," overloaded electrical circuits may break down, pitching large cities into darkness.

Most important of all, the sun keeps us alive. You would have no food to eat, and no oxygen to breathe



Mt. Wilson and Palomar Observatory photo
Prominence rises 140,000 miles. Compare size with Earth (dot).

Sacramento Peak Observatory photo
Prominence over sunspot has form of converging close loops.

if our brilliant mother star were to blink out. In addition, all the Earth's energy, with the exception of nuclear energy, is produced by the single burning mass of gas we call the sun.

Gigantic Atomic Reactor

Where does this energy come from? It is believed that deep within the sun (whose diameter is 864,000 miles) the temperature is probably 27,000,000 degrees F. In this seething mass of exploding gas, nuclei of hydrogen (most common element in the sun) bombard each other at fantastic speeds and are fused into heavier helium nuclei. A by-product of this fusion process is energy. The sun is a gigantic atomic reactor.

But it is like no reactor you and I shall ever see. The sun converts into energy almost 240,000,000 tons of matter each minute. To equal this output, we would have to explode 80,000 coal cars full of TNT *every second!*

The energy released by this constant atomic reaction batters its way toward the sun's surface. Two thirds of the way upward, conditions are such that radiation alone cannot maintain the flow of energy. The solar matter begins to seethe, bubbling to the surface in granules (or convective cells). Each of these has a diameter of 600 miles and carries with it incredible quantities of heat. The upper layer in which these granules appear is called the sun's photosphere. It is an area of 1,000 mph whirlwinds caused by the rapid rising and subsiding of the granules. This turbulent layer is the source of all sunlight.

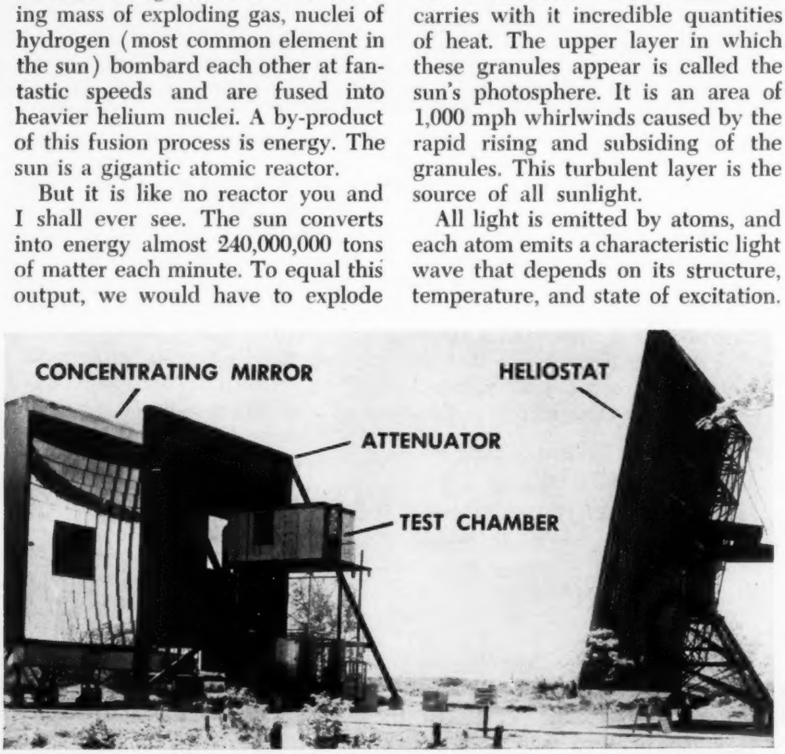
All light is emitted by atoms, and each atom emits a characteristic light wave that depends on its structure, temperature, and state of excitation. Thus, atoms are like radio transmitters of different wave lengths. But instead of a radio dial to tell the solar physicist what station he is receiving, he uses the spectroscope, an instrument that can break the spectrum of visible light into as many as 22,000 distinct lines of color and shadow. Of these, astronomers have been able to "read" more than 12,000. Each tells something about the sun's composition and the turmoil within it.

Churning Sea of Gas

For example, these spectroscopic lines have shown that there is a "color sphere" or chromosphere immediately above the photosphere. This chromosphere, extending about 6,000 miles, is a seething mass of rarefied gases—we might call it the spray of the photosphere—which boil upward at velocities greater than six miles per second. The chromosphere "burns" at temperatures as high as 10,800 degrees F.

Part of the energy of the chromosphere's boiling is transmitted to the outer layer of gas, the mistily glowing corona that the scientists traveled so far to see this month, heating it to fantastic temperatures.

In fact, just a few days ago, the U. S. Navy reported that the temperature in the corona may be ten times hotter than we have thought. A rocket launched as part of Project Sunflare II revealed temperatures of 190,000,000 degrees F. This churning sea of incandescent gas is the source of the X rays that bombard our atmosphere (knocking electrons off the molecules of air and creating



Wide World photo
In solar furnace heliostat catches sun's rays, reflects them to concentrator, which focuses them on test chamber. Attenuator (venetian blind) regulates amount of light.

the ionosphere). Some of the X rays, says the Navy, were measured at 80,000 electron volts.

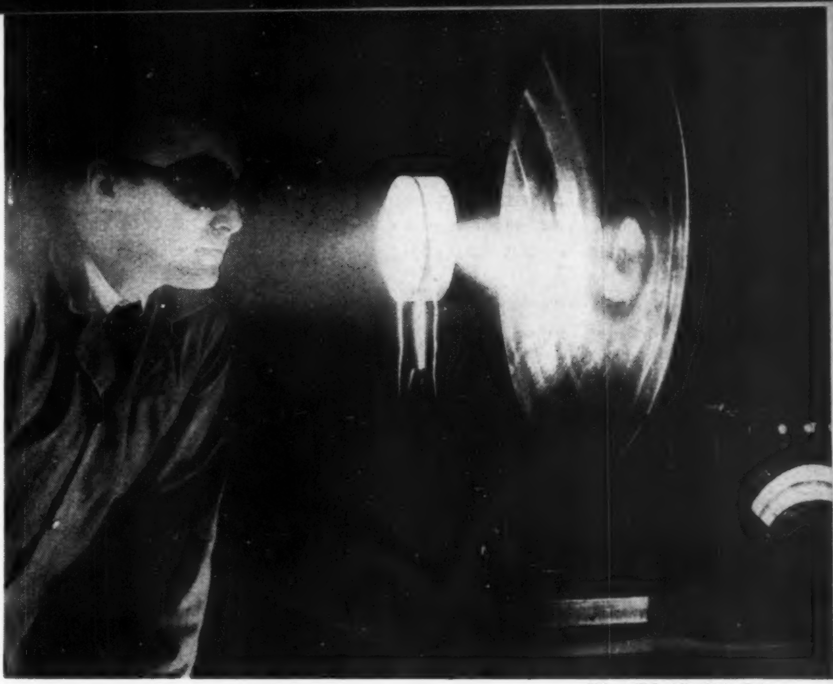
There are, of course, no definite boundaries between the photosphere, chromosphere, and corona. The sun is a flaming mass of brilliantly hot gas and of boiling clouds of charged particles from core to corona. Because this mass rotates faster at the equator (once every 27 days) than it does at the poles (once every 32 days), it also seethes with internal currents that spiral about its axis.

Niagara of Radiation

The turbulence caused by this uneven rotation probably provides power for the storms or "centers of activity" that result in sunspots, faculae, flares, and prominences. These disturbances, in turn, pour forth the niagara of radiation (ultraviolet light, infrared, and radio waves) that affects us and our Earth in many ways. Ten of these centers of activity may boil into existence in one day.

Usually our first sign of a center of activity is the eruption of a luminous cloud of calcium gas in the upper photosphere. These are faculae, streaks of incandescent clouds that are heated by their own magnetic field. You can demonstrate this heating effect in the laboratory by introducing a tube containing a rarefied gas into an alternating magnetic field (the field around a coil carrying a high-frequency AC potential). The gas will glow.

In 1611, the German astronomer Johannes Fabricius wrote: "I directed the telescope at the sun. It appeared to have a variety of inequalities and flaws. While I was observing these carefully, I was unexpectedly shown a black spot. . . ."



Science Talent Institute photo

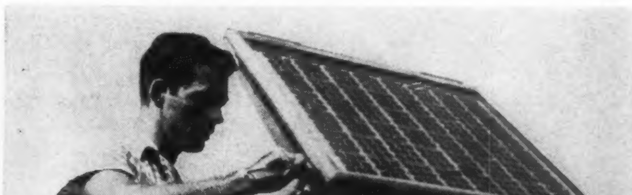
Experimental apparatus is used to generate electricity from heat of the sun. Sun's rays, gathered by large concave mirror at right, are focused on thermoelectric materials. These convert the intense heat directly into electrical energy.

In high excitement, Fabricius wrote to Galileo, who replied that he had seen such spots as early as August 1610. The two were among the first in the western world to see what we call sunspots. These are islands of calm, cooler gas (about 2,700 degrees F. cooler than the surrounding gases) that may extend 30,000 miles across the face of the sun. The largest sunspot ever seen, photographed in April 1947, had an area of 6,300,000,000 square miles. Driven by the uneven rotation of the sun, the spots drift across its face, surviving sometimes for two months.

The spots, originally thought to follow an 11-year cycle (1957-58 was deliberately chosen for the International Geophysical Year because sunspot activity was expected to be at peak—as it was), are now believed to be due to a number of independent processes. In this new hypothesis, each cycle is an independent eruption that takes about 11 years to die down.

Rocketdyne photo

In solar furnace, sun's rays come to hot focus, melt steel in a few seconds. Helium is used to keep oxygen from specimen. Smoke comes from vapors, oil, dirt.



Bell Telephone photo

At Americus, Georgia, sun—ultimate source of all energy man has at his disposal—furnishes power directly to phone line. Solar battery has no moving parts or chemicals. Sun powers Explorer VI batteries.

Astronomers believe that the spots signal the presence of a huge electric current. Sometimes a magnetic field (always associated with a flow of electricity) is discovered before the spot appears. At other times a field lingers after a spot has disappeared.

Sunspots have been tied statistically to violent storms on the Earth, human illness, and the faster growth of trees. We have no proof that they actually *cause* such phenomena. Nor do we know whether these Earth phenomena should be related statistically to the spots themselves, or to the magnificent flares which boil up around them, or to the prominences that sometimes rocket thousands of miles above them.

Flares are like our lightning, gigantic discharges resulting from differences in electrical potential. But the complex "flash of lightning" on the sun's face may last for hours. During its violent life it showers our upper atmosphere with charged particles that disturb our magnetic field and suffuse our polar skies with the *Aurora Borealis* and *Aurora Australis.*

Flares also belch intense ultraviolet radiation. These deadly rays are happily stopped by a layer of the atmosphere 40 miles above the Earth's surface. The flares are the source of X rays, radio waves, and it is believed, cosmic radiation (subatomic particles that move through space with the speed of light).

Particles from the flares are trapped above the Earth along the lines of force of the Earth's magnetic field. These form the Van Allen belts of radiation.

Sometimes huge clouds of gas form in the corona above the sun, exploding to heights as much as 250,000 miles, and climbing at a speed of 450 miles per second. These gigantic outbursts are called prominences. Curiously, they sometimes come to an abrupt halt, and return to the place of their birth at the same speed—like a shell that suddenly returns to the gun from which it was fired. Many prominences, however, last for months, broadcasting intense radio waves. The unpredictable formation and destruction of prominences is believed to result from the sudden development of huge magnetic fields deep within the sun.

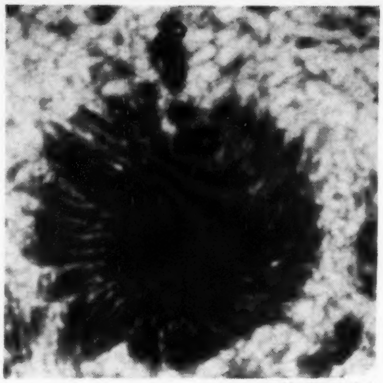
With radar antennae and radio telescopes (*see page 16*), with telescopes, coronagraphs, interferometers, spectroheliographs, cameras, photoelectric cells, and a wide variety of other fascinating instruments —with these we are just beginning to understand this violently exploding ball of gas we call the sun.

Sunlight for Fuel

And we are learning to make grateful use of the tiny amount of the sun's radiation our Earth intercepts. The Massachusetts Institute of Technology has built four "solar houses." The sun's heat is captured in aluminum collectors and transferred to a 1,500-gallon tank of water for later use in heating the rooms.

In India, solar furnaces, polished disks of metal, concentrate the sun's heat to provide inexpensive and clean fuel for a fuel-poor country.

Experts at our Los Alamos Scientific Laboratory have designed a sail that could use the pressure of the sun's light (about 1/100th of a pound per acre on Earth) to propel a space ship.

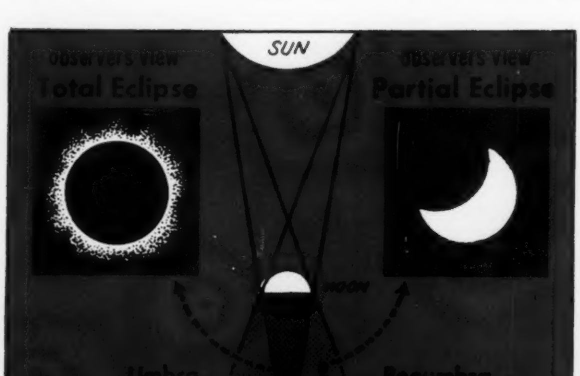


Wide World photo

In sunspot, dark core of relatively cool gases is surrounded by wispy filaments of warmer gases moving out, upward.

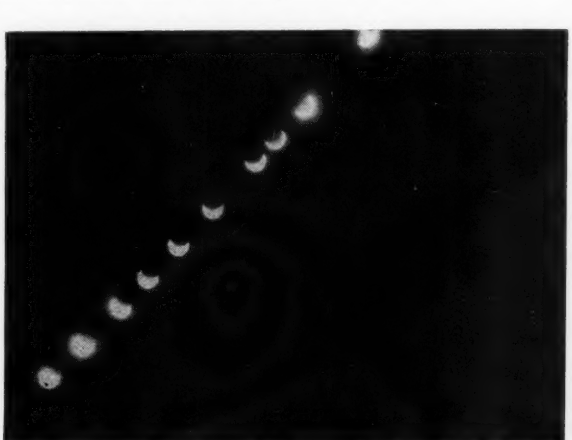
In 1955 scientists at the Bell Telephone Laboratories developed a solar battery. This uses sunlight as a direct source of electricity. Wafers of silicon are the heart of the battery. As sunlight falls on the wafers, a current of electricity is stimulated. The battery operates on the energy supplied by visible light rather than on the long-wave infrared heat rays. Thus it can generate electricity even on cold days when the sky is overcast. The current can be used to charge chemical batteries, and thus be stored for use at night.

Scientists all over the Earth avidly study the sun, for it is our handiest "laboratory of the stars," the only source of energy that appears to be inexhaustible—and it keeps us, you and me, alive.



Wide World photo

In total eclipse moon is in direct line with Earth and sun. Drawings on cover illustrate how an eclipse travels across face of the Earth, and why it is visible in a specific area.



Hayden Planetarium

Dark area appearing on sun as eclipse begins is moon's edge.

By L. SCHUYLER FONAROFF

The Trash That Scientists Treasure

The archaeologist uses geology, physics, and chemistry to reconstruct bygone civilizations

THE refuse mounds of today are the history books of tomorrow. It is the archaeologist whose curiosity turns to the jumbled assortments of animal bones, spear points, splintered pottery, and other refuse discarded centuries ago by now-extinct tribes and civilizations.

Piled up on each other, layer by layer, these castoffs are known to archaeologists as "cultural debris." They constitute to the trained eye an incomplete but often quite revealing record of everyday life and cultural change among the peoples who have settled in successive waves on a given site.

The writer of this article, as an archaeologist, has excavated remains at many major sites. But few have proved so rewarding and illuminating as those found at the Cienega Creek Site, in the southwestern part of the United States.

Before describing the Cienega Creek excavations, the writer would like briefly to sketch the main methods and procedures used in archaeological research.

The first thing an excavator tries to do is to locate the city dump of the settlement he is investigating. When the dump is unearthed, it enables the archaeologist to make a quick but useful appraisal of the city or town to which it belonged. For instance, since broken pots are normally scattered across the surface of the dump, the trained investigator may, without digging further, deduce from these pottery fragments, known as potsherds, the date at which the city or town flourished.

The refuse mounds in the city dump serve additional purposes. They may help archaeologists to locate a settlement area that would otherwise be lost to history. It is impossible for any community to exist without a trash disposal area nearby. These dumping grounds often grow to tremendous proportions. They may eventually elevate the "ground" level as much as 30 to 50 fifty feet or more above the surrounding landscape.

As the mound grows, it becomes an attractive village site itself. Because of its elevated position, it becomes a strategic battle station. At the same time, it assures to those people who settle on it freedom from the wet, soggy soil found in many low-lying areas, as well as immunity from the floods which seasonally ravage many low-lying plains.

Many large cities of the world today are built on the trash mounds of their infancy.

"Autopsy" on a Culture

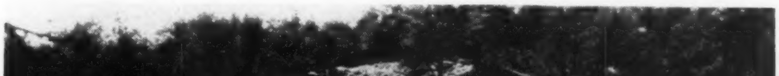
Mound excavations also yield bits and pieces of trash which enable the scientist to detect and record culture change.

Significantly, whether trash has accumulated in well-defined mounds or has merely been tossed out the front door of a dwelling, the oldest material is usually near the bottom of the pile. Any automobile junk yard follows this pattern; the newer cars are always on top of the older models.

Similarly, in ideal archaeological situations, this layer-upon-layer "stratigraphic" principle helps the researcher to detect technological changes within a culture. He simply studies the changing residues thrown off by the culture.

In theory, the archaeologist "doing an autopsy" on a civilization simply removes layers of its surviving debris one at a time, from top to bottom—as one would remove the layers of a layer cake. However, as in most sciences, the details of such an operation are likely to become rather complicated.

For example, how can the trash tossed down a slope by a recent "young" civilization be separated in time from that deposited on the bottom previously, by an "old" culture? Or, how can the excavator ascertain that a given room contains a pile in



All photos by the author

Fig. 1. Cienega Creek site is situated on flood plain of valley. For past 100 years valley floor has been fairly stable, but only few trees have successfully seeded on it. Tarpaulin protects cremation pit from late summer afternoon rains.

which the oldest remains are at the top and the most recent at the bottom? The latter case can and frequently does occur, particularly if in times past a primitive group stumbled onto some deserted ruins, and found them to their liking. The later arrivals may well have disposed of the accumulated debris left by their predecessors merely by throwing the trash into an adjoining, unused room, or even into the areaway outside.

In either event, the material near the floor of the dwelling is the last to go—and it goes on top of the pile. Hence, if enough debris is present, the normal stratigraphy is more or less completely reversed, and the history of change can inadvertently be read backwards.

Clues in the Ground

It may be easy to detect this abnormal situation in an automobile "cemetery." But try it with a few small pottery fragments, some animal bones, a number of unusual spear points, and a variety of hauntingly unidentifiable objects.

It requires careful observation on the part of the excavator to detect those changes in soil color, texture, and other characteristics that help to mark off the layers deposited by man from those deposited by nature. The evidence that one civilization had lived in the buildings constructed by another might otherwise be irretrievably lost.

Within the past few decades our ideas about the archaeological history of the American Southwest have undergone some stirring and momentous changes.

The mountains of east-central Arizona had long yielded remains which indicated that man has lived in the area for at least 2,000 years. Until very recently, our knowledge of the archaeological history of this rough, mountainous country was derived solely from the remains left by advanced agricultural and pottery-making peoples. Now, as a result of excavations at Cienega Creek on the San Carlos Apache Reservation, it is possible to extend the archaeological history of this area back to several thousand years B. C., and to recognize the presence of earlier hunting and gathering people of the Cochise Culture.

The Cochise Culture eventually gave birth to the village cultures of late prehistoric times in central and southern Arizona.

Cienega Creek, like many small river beds, or arroyos, throughout the Southwest, is a relatively new surface feature. Through a subtle change in climate taking place in the latter part of the nineteenth century, many streams and large arroyos of the region began to wear away or degrade their channels. Cienega Creek is progressively eroding its bed. It now flows at a depth of four meters below the level of the plain.

The arroyo walls, in addition to revealing the magnificent layers of soil and rock characteristic of most alluvial valleys, cut squarely through the remains of a very early camp site of the Cochise people.

This discovery, made by archaeologists from the Arizona State Museum, was made possible by the identification of a grinding slab exposed in the arroyo wall.

The excavation which followed revealed aspects of the Cochise Culture and its links with the two succeeding important Southwest cultures: the Mogollon of the mountain areas of eastern Arizona and Southwestern New Mexico, and the desert Hohokam of the basin and range country of southern Arizona.

Fig. 2. Vertical face shows layers of alluvial deposits with large grinding slab and other stone tools in place. Step between Beds B and C-1 separates pottery from pre-pottery times. Valley floor was this level about time of Christ. Note sloping arroyo wall, left. Face of site was excavated vertically to see sedimentary sequence and relative positions of human remains.

Cutting a Vertical Face

No two archaeological situations are ever alike, owing to the difference in location of the various sites, and to the various natural forces which tend to bury or destroy archaeological materials. As a result, a new plan of attack must be adopted for each excavation.

A rather unusual technique was employed in extracting material from the Cienega Creek Site. To strip the layers of sediment, beginning at the top and working down, as one does on most archaeological sites, would have been impractical. In the period since the Cochise people lived in the region, sediment has been deposited

on the valley floor to a depth of several meters (one meter is equal to 39.37 inches), completely obscuring the horizontal extent of the site.

It was decided under these circumstances that the best way to extract the artifacts, or man-made remains, from the soil would be to cut a vertical face into the bank by removing vertical slices a quarter to a half-meter thick, depending on the nature of the archaeological features encountered.

By using this technique the scientist may more easily study the succession of geological events which have occurred during the filling of a valley. Climatic changes, such as that presently causing the degrading of Cienega Creek, may be detected. Or possibly the deposition of great quantities of sediment may reflect an increase in rainfall.

This increase could, in turn, indicate the onset of a period dominated by glaciers, since it is believed that ice fields cannot accumulate over the earth's surface without acquiring the moisture supplied by large amounts of rain.

Reading the Evidence

In the accompanying photographs, the various levels or strata of the Cienega Creek Site are marked from A downward to E.

The presence of human activity at Cienega is first evident in layer *D*, through the appearance of fire hearths, water wells, seed-grinding stones, and a tremendous amount of charcoal (*see Fig. 2*). The upper portion of this black carbonaceous material represents the earliest deposit of cultural debris found; it extends for a distance of 100 meters along the arroyo bank. Laboratory analysis of the charcoal specimens has dated them—and indirectly the bed in which they occur—at approximately 4,000 years of age.

In other words, the archaeologist has supplied the geologist with a bit of information both useful and hard to come by. It is now an established fact that the level of the valley floor has been raised about 3½ meters as a result of sediment being deposited on the plain for 4,000 years.

Each succeeding campsite, burial ground, or water hole has suffered the same fate—burial in the continually rising valley floor.

The present occupants of the valley, the San Carlos Apache Indians, merely represent another group whose temporary occupation of the area can lead only to the deposition of another layer of cultural debris for other archaeologists to decipher a thousand years hence.

Lack of animal bones in the *D* layer suggests that Cienega should not be considered as a place where people settled permanently. At the time when the valley floor was at the *D* level, and the cultural debris comprising this layer was deposited, the Cochise people was considerably dependent upon the hunting of game.

The presence of grinding tools, fire hearths, and also a well dug from the surface of the *D* layer into the sandy, water-bearing layer *E* (*see Figs. 2 and 3*) implies that the area was used at that time almost exclusively for food preparation.

A search of the *D* layer throughout its exposed area failed to turn up the location of the village site itself. Apparently it is completely concealed, though lying nearby, by the overlying sediments of the plain.

The next youngest layer, *C*, is divided into three strata, *C-1*, *C-2*, and *C-3*, from top to bottom (*see Fig. 2*). This breakdown is due to slight differences in the texture and composition of the soils. It is in the *C-3* level that the exposed grinding slab was located; this find led to discovery of the site.

Preserving Artifacts

It is believed that the *C-3* level was deposited about 2,500 years ago. Contents of this level include additional grinding slabs, plus a cremation burial deposit in a basket. The basketry itself was miraculously preserved for this great length of time because of the perpetually water-logged environment provided by this level.

Decay appears to act very rapidly when there is an alternation between a wetting and drying out of the lay-

Fig. 3. Complete sequence of layering of sediments is shown. Water well in foreground was dug when valley floor was at the D level. It dates from earliest occupation of the site. The well behind was dug from the middle of the C layer. This was the ground level more than 2,000 years ago.

ers, so that the salvaging and preservation of the basket required that it be extracted from the wet ground and placed directly in a container of water, in which it was carefully cleaned. The basket was then washed in acetone and immersed in a gasoline-paraffin solution.

After several days of immersion, it was removed and dried in the air. The gasoline evaporated and left in the fibre structure of the basket molecules of paraffin which acted as a binder. With this type of preservation, material could be handled and studied safely.

The *C-2* bed contained a large, excavated pit which held remains from 40 of the 47 cremation burials found at the site. This pit was 3 meters in diameter and 1.3 meters deep. Most of the cremations were placed in a small hollow within the pit and capped with a flat rock. In many of these individual burials the funeral party had placed a grave offering, usually consisting of either a projectile point or a stone pipe.

At the time this burial pit was dug, the floor of the valley had risen considerably. Probing for water had become increasingly arduous. The water-bearing stratum, *E*, was continually being more deeply covered by the rising valley floor.

Level *C-1* proved sterile, with no signs of human occupation except for another, still deeper, well. Pottery was found in the succeeding sediment. Hence we can date the deposition of the *C-1* level as immediately prior to the introduction of pottery into the area, or about the year 1 A.D.

Detecting Changes

Layer *B* contained the first specimens of pottery. The pottery was of the variety made about 1,000. It consisted of shards broken from vessels used for cooking and storing water. Apparently the presence of the water-bearing strata, now deeply buried, was known and utilized. A well was dug when the surface was at *B* level, and a depth of nearly four meters now had to be reached for the water to be obtained.

The uppermost level of the site, level *A*, consisted of an easily identifiable soil layer nearly ½ meter thick *(see Figs. 2 and 3)*. This level produced no artifacts within the area of the site explored, but it probably contains potsherds and other artifacts from the fourteenth century Pueblo ruin located on a nearby hill (*see Fig. 1*).

The present-day Apache inhabitants of the area recognize the value of the area for its water. They have dug wells from the present level, unaware that they are perpetuating a precedent established at least 4,000 years ago.

The Cochise Culture is known from other sites, and its dated remains indicate its presence in southern Arizona for at least 10,000 years. During the thousands of years of the culture's existence, many changes are detectable. The most rapid and significant of these changes occurred in the historical segment recorded at Cienega Creek. Cienega represents the last 2,000 years of survival of the Cochise people as an identifiable cultural entity.

Hunting to Agriculture

It is during these 2,000 years that the subsistence patterns of the Cochise people shifted radically from a general hunting and seed-gathering existence toward one based on an agricultural economy. This change is reflected by the greater frequency of grinding and agricultural tools, and by a sharp reduction in the occurrence of projectile points and other hunting implements. This, the final stage of the Cochise Culture, corresponds with the period when agriculture was believed to have come into the area from the south, some time during the millennium before the Christian era. The precise route of this migration is still unknown.

Linkage between the Cochise Culture and the Hohokam and Mogollon peoples of post-Christian times is strengthened by evidence gathered in the excavations. At last it is understood where the Hohokam agriculturalists acquired their custom of cremating the dead, and where the Mogollon mountain people acquired the shapes of their projectile points as well as their smoking pipes.

Thus, in the exposed cut of a stream was found evidence that there is indeed always something new under the sun. The values and tastes of any group are always changing—changing into combinations of ways of doing things and of thinking of things that were never tried before.

As such, history can never repeat itself—the raw materials are never the same. The changes that have occurred at Cienega Creek began rather slowly within a hunting type of existence. With the spread of the ideas of agriculture and of pottery-making, coming from the south, the culture patterns of the area changed so quickly and radically that the Cochise civilization ceased to exist as such.

Those peoples who preferred the agricultural life of the southern Arizona desert subsequently became known as the Hohokam—direct ancestors of the present Pima and Papago Indians.

The remainder, preferring a more adventurous existence, favored the game and wooded mountain country of eastern Arizona. By the time the Spanish appeared in the Southwest, they had disappeared as a cultural entity.

The picture is developed. Another chapter of history is recorded. All that remains at Cienega are spoil mounds of excavated dirt no longer containing the artifacts of civilization or the record of geological change. The dirt can no longer be read.

Last Copy of a History

An archaeological site is, in this respect, a unique historical situation. It is like the last surviving copy of a history book. To remove the layers of human work improperly is comparable to tearing out the chapters of such an irreplaceable book and tossing them to the winds. They are gone forever, for in order to extract the story from the ground, complete destruction of a site is virtually necessary.

Yes, the archaeologist's stock in trade is trash. But from this trash his curiosity and inventiveness can reconstruct bygone civilizations. To do this requires him to call upon many human endeavors. Sometimes he is an art historian, at other times a geologist. He may use the tools of a physicist or the materials of a chemist. He must be able to gather clues from bits of plants long since dead as well as those growing now in his "dig." In fact, archaeology is a wide open hunting ground for people who like to put together nature's greatest puzzle—human history.

By RICHARD BRANDT

The revolution in our diet may lead to a more vigorous America

Nutrition—Stanch Ally of Medicine

A QUIET revolution has been taking place in America—right on your dinner table. The revolution has not been making many headlines, but it has been remaking the American people. Our diet has been changing.

We eat less, but we eat better. We are healthier, and we live longer—thanks to the science of nutrition, a development of our century.

Yet the food we eat today provides us with fewer calories than we consumed 50 years ago. The Department of Agriculture reports that in 1909 we took in about 3,600 calories per person per day. Today we consume 3,200 calories. This represents a drop of 400 calories—slightly more than 10 per cent.

A backward glance into history gives us the reasons for this decline in our calorie intake. In 1909, 35 per cent of Americans lived on farms—compared to about 13 per cent today. As farmers they did heavy work, and burned more calories. We now live in an age of mechanization and automation. The amount of work our muscles are required to do has been greatly reduced. In the factory, in the home, and even on the farm, labor-saving devices have reduced our energy requirements.

What We Eat, and Why

There are still other reasons for the over-all decline in calorie intake. This is the first time in our history when there are fewer teen-agers in relation to the total population. There are also more women than men. The increasing proportion of elderly persons and women affects the total amount of food that is consumed. Women and older persons usually eat less food than do younger adults.

More of our calorie intake today comes from fats, and less from carbohydrates. In 1909 dietary fat in the food supply was about 126 grams per person per day. In 1956 the amount of fat consumed per person jumped to 148 grams. Where does the fat come from? We now eat *greater* quantities of meat, fish, poultry, and salad dressings.

Our most important sources of protein in 1909 were flour and cereal products. Today meat, fish, and poultry rank first, followed by dairy products, flour, and cereal products. Since 1946 the amount of protein per person has been constantly decreasing. Today it is slightly lower than it was in 1909.

The increased intake of meat and poultry adds to our supply of B vitamins and iron, as does the enrichment of bread and flour. On the other hand, there has been a decrease in our consumption of grain products, nuts, and dry beans, which also are important sources of these nutrients.

Wheat Flour Institute photo

In controlled experiment, rat A lived on diet of only enriched bread. Notice size. Rat B lived on diet of only pasteurized whole milk. Notice ruffled fur of A and B. Rat C had diet of bread and whole milk. From this diet, rat gets needed nutrients.

Vitamin A and C intake increased steadily from 1909 to 1946. Increases in the use of green and yellow vegetables, citrus fruits, and tomatoes accounted for this. The Department of Agriculture reports, however, that since 1946 there has been a decrease in the consumption of fruits and vegetables, thus reducing our intake of these vitamins.

How did this revolution in our diet come about? The revolution began in the laboratories of hospitals, drug firms, food manufacturers, and universities. It was touched off by experiments involving animals. The experiments were simple—many could be done in any high school biology classroom. But their results were far-reaching.

Putting Vitamins to Work

One of the earliest experiments involved the part that vitamin D plays. Investigators used four 25-day-old albino rats as their subjects. The four rats were segregated into two groups of two each. Each group was put into a separate cage.

One group was fed a diet that was complete with the exception of vitamin D. The second group received the same diet with viosterol added (a source of vitamin D). Both groups received adequate supplies of water daily, and the cages were kept out of direct sunlight. Each day a record was made of the weight and appearance of each rat.

At the end of the third week, the effect of the diet deficient in vitamin D became apparent. The rats on this diet stopped growing. They were wobbly and their fur was ruffled.

Part two of this experiment was then put into operation. Viosterol was added to the food of the rats on the deficient diet. Again the rats were weighed every day. The stunted rats quickly began to gain weight and a healthy appearance.

Vitamin D thus was found to be an essential part of a rat's diet.

How do experiments such as these apply to human beings? The answer is best given by relating one of the early breakthroughs in the science of nutrition.

The time was the early 1930's. The place was Birmingham, Alabama. About 5,700 men, women, and children were suffering from muscular pains, mental and nervous ailments, and a depressed state of mind. These were the symptoms of nutritional deficiency disease. Dr. Tom D. Spies of Hillman Hospital in Birmingham set out to learn what caused the disease.

DuPont photo

Rat eats specially prepared meal. Appetite and eating habits are of significance to scientists, for rat's digestive system functions much like that of human's.

With his associates, Dr. Spies examined these patients and made many laboratory tests. One by one, the known chronic illnesses, such as heart disease and tuberculosis, were eliminated as the cause. But the mystery deepened. In this group were more than 800 people who could not make the slightest movement without suffering great pain.

Dr. Spies decided to try science's newest discovery—the vitamins. From laboratory studies he knew that when certain vitamins were missing from an animal's diet, the animal's vital functions slowed down. It became ill.

Medical researchers under Dr. Spies' guidance developed diets rich in proteins, minerals, and natural vitamins. To these diets they added large doses of synthetic vitamins. The patients soon ceased to suffer. All were eventually able to go back to work. Medicine had enlisted a new ally in fighting and conquering disease—the science of nutrition.

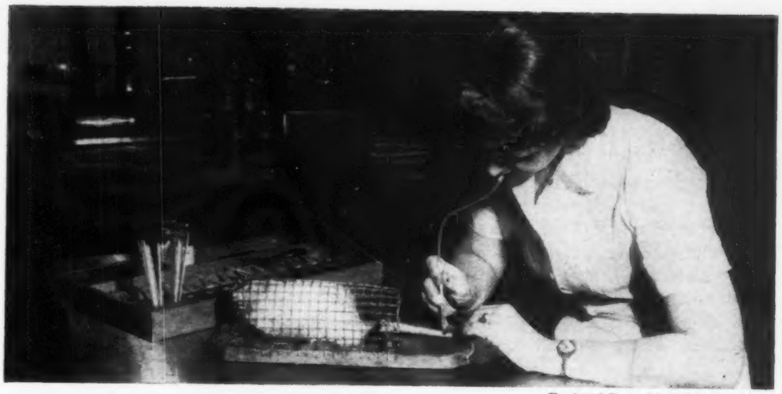
Scientists began to investigate diet deficiencies. They found that various forms of anemia, severe nerve injury, hemorrhages due to fragile capillaries, thyroid gland injury, bone changes, skin disorders, dryness of the eyes, and many other kinds of symptoms were often the result of inadequate diet.

Thus scientists concluded that a particular disorder might accompany a lack or insufficient amount of a particular nutrient. The deficiency could be overcome by adding the missing nutrient to the diet.

How Food Serves You

What is the function of food in the body? Food does more than just satisfy your appetite. It provides you with three things: fuel for heat and energy; structural material for growth, upkeep and renewal of body tissues; and substances regulating and maintaining body processes. One item of food may serve you in one, two, or all three of these ways.

Your diet is made up mostly of proteins, carbohydrates, and fats. A small fraction of the total weight of the nutrients consists of essential minerals and very small amounts of vitamins. Studies of the functions of vitamins indicate that you get all the vitamins you need by selecting your



Food and Drug Administration photo

Count of red and white cells in blood sample of rat tells whether rat is anemic.

food wisely. Vitamins in pure or concentrated form should not be taken unless prescribed by a physician.

The younger you are, the more damaging nutritional shortages can be. During embryonic life, infancy, childhood, and even adulthood, your body is continuously building new tissues. What will be the condition of these tissues? That depends upon the condition of the tissues built previously.

Next Target—Aging

In the past 25 years, America's population has doubled. Also, there are now four times as many people who are more than 60 years of age. Antibiotics, vaccines, and various other curative and preventive measures are helping science to prolong life. The next step is for science to enable us to maintain health and mental vigor for as long as possible. Scientists believe that adequate nutrition may be a major factor in safeguarding health and increasing the human life span.

How long will you live? The answer to this question involves your heredity, way of living, and the diseases which may affect you. The most important factor, says Dr. Henry J. Bakst of the School of Medicine of Boston University, may be "the chemistry of food within your body." Slight dietary deficiencies may build up as you grow older, and contribute toward physical disorders. These deficiencies may occur before any symptoms become apparent.

A diet low in starches, fats, and sugars, but high in minerals, vitamins, and some proteins may be the key to a vigorous and long life. This diet should begin in early childhood and be constantly maintained. Not only may such a diet extend the prime of life, but it may postpone the degenerative processes of old age. These conclusions are borne out by the results of experiments done two years ago on laboratory animals at Cornell University.

Many scientists are hard at work trying to solve the problem of nutrition. One of the scientists in the vanguard of this group is Dr. Tom D. Spies. Two years ago he was awarded the highest honor of the American Medical Association—the Distinguished Service Award. When he received the award, Dr. Spies outlined his scientific credo. This is what he said:

"All diseases are caused by chemicals, and all diseases can be cured by chemicals. All the chemicals used by the body—except for the oxygen which we breathe and the water which we drink—are taken in through food. If we only knew enough, all diseases could be prevented, and could be cured, through proper nutrition.

"I expect to devote the rest of my years to trying to help older people. We don't want just to give them a longer life—we want to preserve the prime of life for a longer time. As tissues become damaged because they lack the chemicals of good nutrition, they tend to become old. They lack what I call 'tissue integrity.' There are people of 40 whose brains and arteries are senile. If we can help the tissues repair themselves by correcting nutritional deficiencies, we can make old age wait."

A Look Ahead

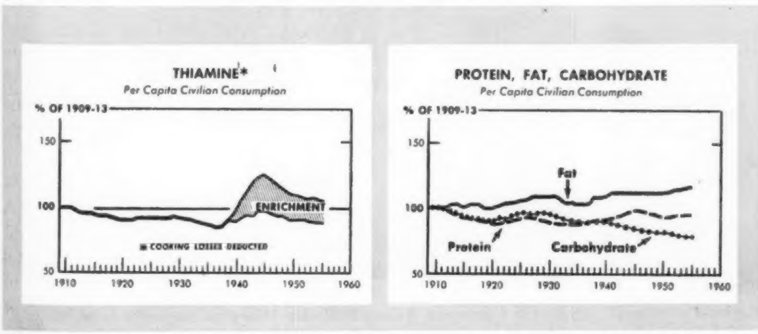
How is Dr. Spies carrying on his work? He is now doing research on "susceptibility tests to show which people are aging too fast—and which are liable to develop certain diseases—because they lack the chemicals to repair their tissues."

One test involves saliva samples. This test measures the subject's susceptibility to tooth decay. Another is concerned with gastric fluid. It indicates the chances of getting pernicious anemia. "In all these cases," notes Dr. Spies, "we know the danger of the disease before it occurs."

Dr. Spies says: "I can foresee the day when we will have a much stronger, healthier—and happier—population."

However, the science of nutrition is still in its infancy. And its paths may lead in many directions.

Looking ahead, there are many questions that need to be answered. Much more information about fats and proteins has to be gathered. For about one half the world's population the science of nutrition focuses on securing an adequate intake of good quality protein.



Department of Agriculture

Graphs show changes that have taken place in our eating habits over past 50 years.

Science in the news

Ears on the Universe

As the Soviet satellite orbited around the moon, the whole world was watching its progress. Not directly "watching" it, for the satellite was too small to be visible even to the best optical telescopes—but watching it by reading reports of scientists working with radio telescopes. These are the only instruments capable of catching the faint radio signals from the satellite.

For most of the world, word on the satellite's progress came from the largest radio telescope now in existence, the 250-foot-diameter "dish" at Jodrell Bank, England.

The British "dish" is actually a metal reflector which collects radio signals from anywhere in space and focuses them on an antenna placed near the center of the dish. The antenna is connected to an extremely sensitive receiver. The dish is in the shape of a parabola, like the mirror in an optical telescope. But there is an important difference between a radio telescope and an optical telescope. The optical telescope is an eye which "sees" a picture. The radio telescope is only an "ear" which listens to radio signals and records them on paper.

Thanks to the big reflector dish, however, it becomes an extremely sensitive ear which can be pointed very precisely in any direction. In general, the bigger the dish, the more sensitive the "radio ear" becomes, and the farther it can hear.

A fantastically large radio telescope is now being built by the Navy at Sugar Grove, West Virginia. This will have a 600-foot-diameter reflector dish—equal in length to two football fields and larger than seven acres in area. The whole dish will turn so as to point in any direction.

38 Billion Light Years Away

It will enable Navy scientists to tune in on radio signals from celestial bodies as far as 38 billion light years out in space, 19 times the distance probed by the world's largest optical telescope, the 200-inch instrument at Mount Palomar, California.

The Navy telescope will be able to pick up signals from satellites exploring the solar system, or it may even receive television signals from satellites near Saturn, one of the most distant planets. Most important, it will be able to listen to radio signals from all parts of the universe.

By listening to radio signals, astronomers have learned that there are many celestial bodies speeding and colliding through outer space whose existence they never even suspected. Areas of the sky in which we cannot detect glowing stars or galaxies on a photographic plate, are full of bodies which emit strong radio signals.

When a radio telescope was pointed in the direction of the constellation Cygnus, a body in that direction was found to be pouring out radio waves at the fantastic rate of 1,000,000,000,000,000,000,000,000,000,000 (30 zeros—10^{29}) megawatts. (An average broadcast station may operate on only one tenth of one megawatt.)

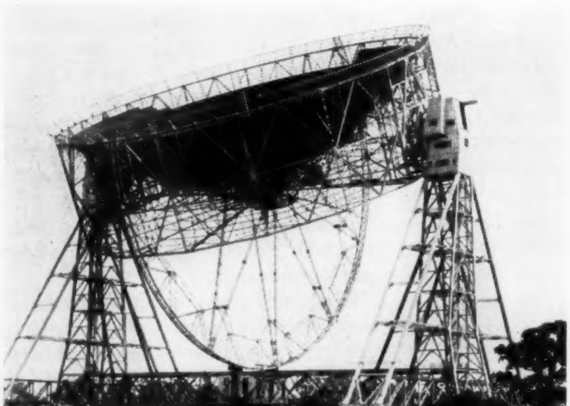
Although the area was photographed with the most powerful optical telescopes, only a tiny smudge of light showed up on the photographic plate.

This evidence was interpreted as one of the most fantastic events in the observable universe—nothing less than the collision of two galaxies.

The radio signals coming from the collision are generated by clouds of gas colliding at astronomical speeds, thereby exciting the atoms to the point where they generate radio waves.

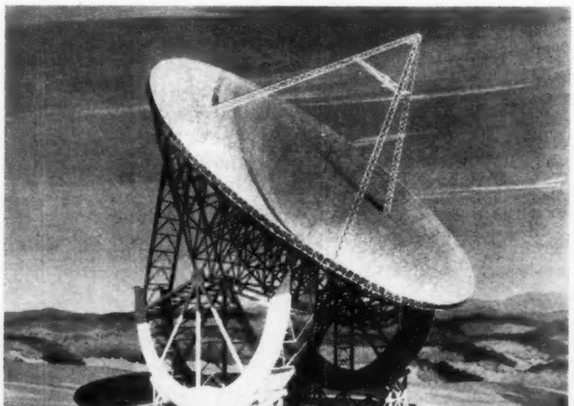
Atoms of different elements generate different types of radio waves. Thus astrophysicists can deduce from the wave length and intensity of radio signals the chemical composition of distant stars or galaxies.

Glowing bodies such as the stars, our



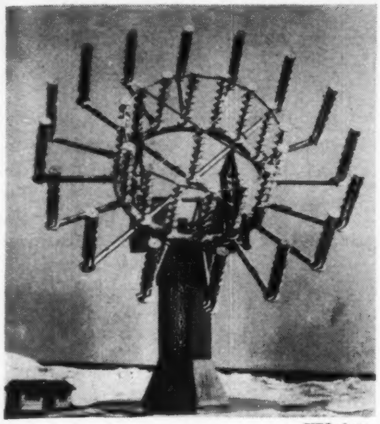
British Information Services photo

Radio telescope at Jodrell Bank, England, is world's largest at present. Diameter of dish is 250 feet. Range of instrument depends upon the strength of radio signals being received.



Grad, Urbahn & Seelye

Radio telescope being built by Navy at Sugar Grove, W. Va. (*drawing above*), will be world's largest when completed in 1962. Dish diameter would extend across two football fields.



UPI photo

New lightweight antenna to be installed at Wallops Is., Va., in 1960 will track space vehicles and guided missiles. Antenna needs less space than dish type.

sun, or the comets generate radio signals, as do dark bodies such as the planets, the masses of cold stars, or the gas clouds floating through the universe.

The discovery that radio waves come to Earth from outer space was made by a Bell Telephone engineer, Karl Jansky. While developing a radio-telephone between Europe and the U.S. in 1932, he tried to eliminate all static and interference. One by one, he identified the radio signals that affected his intercontinental system. But he still had some "unknown" interference. These signals were finally traced to the stars, the planets, and the sun.

The Radar Telescope

But there are many bodies whose radio emission may be too weak for the sensitivity of the radio receiver—too weak to yield useful information. To overcome this, scientists have used the radio telescope principle to design powerful radar telescopes

A radar telescope sends out its own radio signals and then listens to the echo. Radar pulses are beamed out from the big reflector dish like the rays from a flashlight. The transmitter is then quickly shut off and a receiver tuned in to catch the echo (all in a small fraction of a second).

A new radar telescope being built at Stanford University in California will have a 142-foot dish and a 1,000,000-watt transmitter – sufficient power to reach Venus and pierce the perpetual cloud layer surrounding it.

The Stanford radar telescope will be able to make extremely accurate distance measurements by measuring the time it takes for the echo to return. It will be able to chart the surface of the moon or Venus by pointing the radar beam at various spots along the surface and recording the echo time interval.

A radio wave takes just two and one half seconds to make a round trip to the moon.

Most important, the radar telescope will be able to make very accurate measurements of distances between the planets. Small meteors crossing the radar beam will appear as blips on the recording equipment.

Although both radar and radio telescopes can gather a great deal of complex information about the universe, they are basically simple instruments.

Inspired by the huge Jodrell Bank telescope, some British high school students have built their own private radio telescope—for less than $40. Made of wire, wood, and parts from an old TV set, the 12-foot dish pulled in signals from the sun, the Milky Way, and the constellation Sagittarius.

It proves that in science, as anywhere else, interest and imagination count most.

Blood on the Ready

Fire sweeps through a town; a train is wrecked; a hurricane ravages a city—disasters such as these bring emergency calls for blood.

Each year 5,000,000 transfusions are given. Where does this blood come from? At present, blood is collected as it is needed.

But whole blood can be stored for only 21 days at most. After 21 days, the red blood cells begin to age until they die.

We need a ready supply of blood to meet all emergencies. The freezing of blood and blood components may provide the answer to this growing need.

Captain Henry T. Gannon, a Navy medical officer, has reported that techniques are being developed that will make possible long-term storage of whole blood and its components.

Stored frozen red blood cells have already been used experimentally in transfusions. Physicians at the Chelsea Naval Hospital in Massachusetts have not observed any unfavorable reactions.

Dr. Gannon has suggested establishment of individual blood-bank accounts. If a person needs blood, it could be supplied from a bank of his own blood.

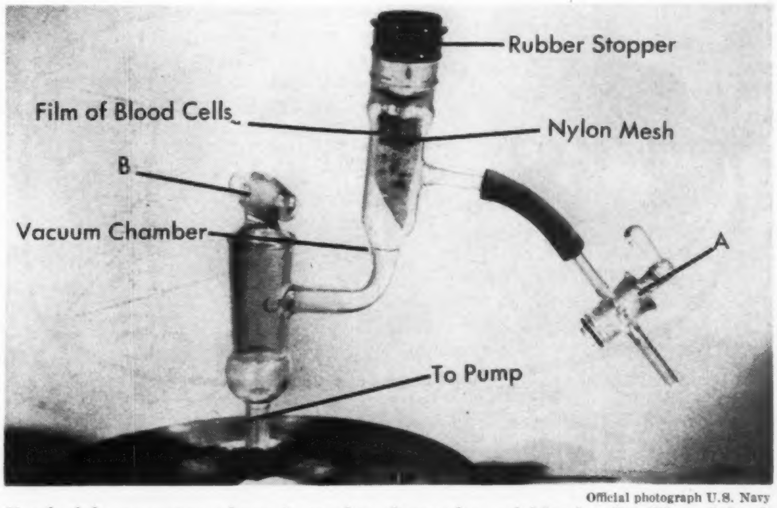
Freeze-Dried Cells

Research by Dr. Harold T. Meryman of the Naval Medical Research Institute at Bethesda, Maryland, may give us another method for preserving blood.

Dr. Meryman and Emanuel Kafig, a technician, froze and dried human red blood cells into a ruddy powder. This was done by putting a film of blood cells in suspension on a nylon mesh suspended in a vacuum chamber. By quickly reducing the pressure in the chamber, water is driven out of the cells and they are frozen at the same time. In the vacuum, the ice changes into water vapor without first condensing into a liquid. This results in the cells being dried.

Dr. Meryman described the process as being "extremely simple" (*see illustration below*). He told *Science World* that it takes a total of six minutes to freeze and dry blood cells in the apparatus he devised.

When dried blood cells of rats are reconstituted to the living state and injected back into the bloodstream of rats,



Official photograph U.S. Navy

Simple lab apparatus above is used to freeze-dry red blood cells. Film of fresh blood is placed on nylon mesh attached to rubber stopper. Stopcock B is opened, creating vacuum. Freezing and drying result. Vacuum is broken by opening A.

Science in the news

the cells survive. However, these are not stored cells. Human red blood cells have been reconstituted after being stored for a year (though not used experimentally). Dr. Meryman reports that the human blood cells were no older when reconstituted than they were when freeze-dried.

Moon Sees Red

On October 4, the Russians celebrated the second anniversary of Sputnik I in a big way. They added another candle to their birthday cake by launching a space probe around the moon.

The United States had hoped to use an Atlas-Able rocket to launch a lunar probe between October 3-6. But it exploded during ground tests.

Both the U.S. and Soviet space probes were apparently timed to take advantage of the fact that the moon was less than 226,000 miles away from the Earth at that time. Its mean distance is 238,857 miles.

The Soviet space probe did not make a full circle around the moon. Instead it traveled in a path across the "dark moon." The satellite requires 15 days to complete its elliptical orbit.

The path of the probe was based on the laws Johannes Kepler formulated in 1609 for calculating the motions of celestial bodies.

At the time *Science World* went to press, it was not known whether the satellite was equipped to photograph the side of the moon never seen by man. The 613-pound satellite carried "scientific and radio technical equipment," including a solar and a chemical battery, and two radio transmitters. Each transmitted signals on a different frequency, changing back and forth every one to two seconds.

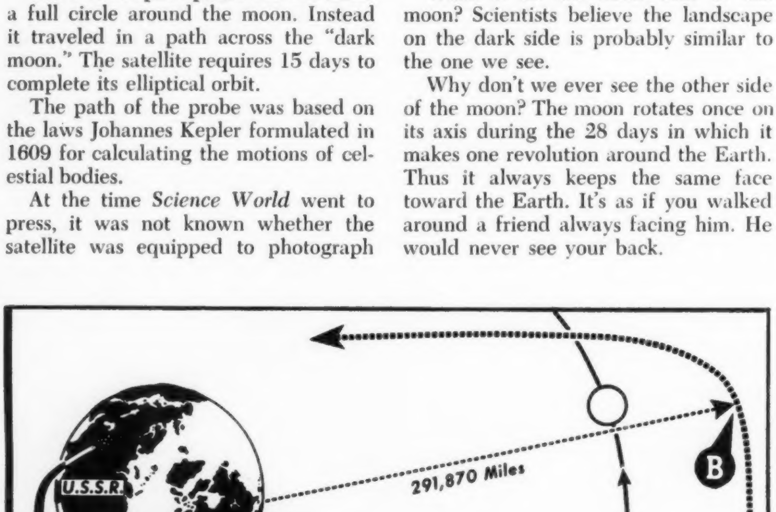
Scientists manning the Jodrell Bank radio telescope in England heard the higher of the two radio signals. The sound was that of a note pitched at about "A" above middle "C."

It is estimated that the satellite reached a velocity of about 25,000 miles an hour shortly after launching, then lost speed rapidly. It gained some speed again as it came under the influence of the moon's gravitational force.

In the eighteenth century, Sir Isaac Newton calculated that a maximum speed of 25,000 miles an hour would be reached by an object falling toward Earth from outer space. For a missile to escape into space from Earth it would have to be fired at that speed.

What is on the other side of the moon? Scientists believe the landscape on the dark side is probably similar to the one we see.

Why don't we ever see the other side of the moon? The moon rotates once on its axis during the 28 days in which it makes one revolution around the Earth. Thus it always keeps the same face toward the Earth. It's as if you walked around a friend always facing him. He would never see your back.



Soviet probe is believed to have looped around the moon as moon progressed through part of its orbit around Earth. From points A to B, course of probe flattened.

Radiation Satellite

An Army four-stage Juno II rocket successfully launched an Explorer VII satellite October 13.

The ninety-one-and-a-half-pound satellite, shaped like a gyroscope, was shot into space to measure the radiation of the sun and to study how the Earth's weather is formed.

The satellite circled the Earth every 101 minutes. It is expected to remain in space for at least 20 years. As the satellite was launched it was set spinning at a rate of 450 revolutions a minute. This produced the stabilizing effect of a gyroscope and reduced the tumbling that has plagued other satellites.

Seven major experiments are to be conducted by Explorer VII. One of the most important experiments will measure the "heat budget" of the Earth—the amount of energy the Earth receives from the sun and the amount radiated back into space. The heat budget determines the flow of energy through the Earth's atmosphere and establishes the basic weather pattern of the Earth.

Bold Orion

A B-47 crew aimed a ballistic missile to a point in front of the Explorer VI satellite and fired. The missile, a 37-foot, two-stage rocket, reached a point four miles above the satellite, then plunged into the Atlantic. No attempt was made to intercept or knock down the satellite. The experiment was designed to test the accuracy of the missile's guidance system.

The shot took place as the path of Explorer VI—streaking through space at 18,000 miles an hour—ran northeast across the Atlantic Ocean.

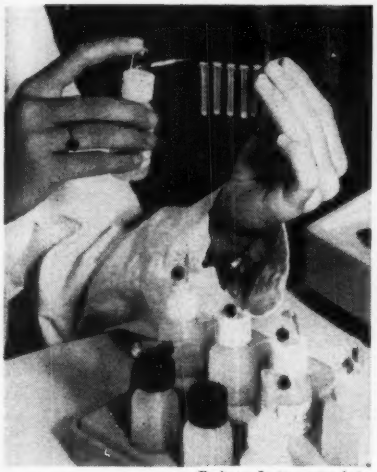
The missile, dubbed Bold Orion, is part of a program designed to give the U.S. a new weapon in the race for space. The weapon is intended for long-range attack, and for catching and destroying satellites in orbit.

"Hams" to Rescue

If you are a radio "ham," the National Academy of Sciences needs you. Dr. Richard W. Porter has asked the American Radio Relay League to request members to record, where convenient and possible, radio signals transmitted from Vanguard III on a frequency of 108 megacycles.

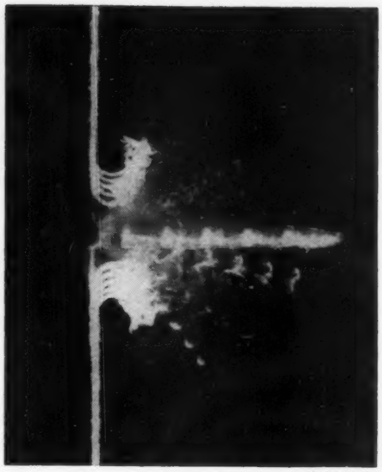
In the event a solar flare occurs, the Academy will notify the ARRL, requesting that members send in tapes made during that period.

Help from "hams" was asked "in order to broaden the possibility of catching a solar flare at the right time, or



Beckman Instruments photo

New ultramicro blood analysis technique permits clinical tests to be made with tiny sample taken from patient's fingertip, ear lobe or heel instead of vein.



UPI photo

Six exposures were made to capture shot of bullet piercing string. Each flash was at millionth of second, hundred thousandth of a second between exposures.

catching certain parts of it that might not be caught by our Vanguard ground stations," Dr. Porter explained.

Scientists are particularly eager to obtain tape recordings of transmissions that show effects of any solar flare that might occur when the satellite is below the Van Allen radiation belts.

If you are a radio "ham" you can do your part in the race for space. A word of caution though, radio amateurs are urged "not to experiment" with radio broadcast signals on frequencies that might trigger a rocket misfire or interfere with ejection of satellite payloads.

Sleeping Sickness

A deadly virus has brought death to 20 victims and sickness to 28 others in New Jersey.

The virus is carried by a night-flying mosquito. When the mosquito bites its victim, its salivary glands deposit the disease-bearing microscopic organism. Eastern equine Encephalitis, the disease spread by this virus, is a form of sleeping sickness. Within the past few weeks, in the rural lowlands of New Jersey, every mosquito seen has been a potential carrier of this disease. *Culiceta melanura,* the mosquito which carries the virus, receives it from wild birds, especially pheasants, and then transmits it to other animals and humans.

The best defense against the virus-carrying mosquito is to eliminate it by intensive spraying of poorly drained wooded areas. Such a drive is currently underway in New Jersey to halt the spread of the disease.

Public health experts claim that the human disease does not reach serious enough proportions in the United States to warrant the development of a vaccine for mass inoculations. In most years, the number of cases does not exceed several hundred.

"Sputnik Grass"

A carpet of death is smothering the Eastern Long Island scallop crop. Spreading rapidly in winter as well as in warm seasons, the spongy carpet threatens to destroy all fishing and shellfish farming in the bays of Long Island.

The carpet's fiber is in the form of one-celled plants—algae—identified as *Codium fragile.* Until recently, these were unknown on the eastern coast.

The spongy plant first became evident at the time the Soviet Union sent its first Earth satellite into orbit two years ago. For this reason, baymen call the algae "sputnik grass."

"Sputnik grass" covers the scallop and prevents it from moving about. It sinks to the bottom and smothers in the spongy mass, or remains undeveloped in an immature stage.

The living carpet of algae also uses up the nutrients that support the microorganisms which, in turn, provide food for swimming fish. With the biological balance of the waters upset, the fish leave for favorable feeding grounds.

Father of Solar Power

Dr. Charles G. Abbot, former secretary of the Smithsonian Institution and still active as one of its research associates, has patented a solar heater.

Dr. Abbot, now 87, knows his subject well, having studied it for 60 years. He has been called the "father of solar power."

He believes that his solar heater will bring new hope to the arid regions of the Southwest by producing steam power as cheaply as coal will produce it in Pennsylvania.

How will this be done? Dr. Abbot's heater uses a rectangular parabolic (concave) mirror that focuses the sun's rays continuously on a blackened metal tube, filled with a liquid and enclosed in glass. The mirror is rotated by a motor to follow the sun by turning at an angle of 15 degrees every hour.

The liquid within the metal tube receives the concentrated heat of the sun and carries the energy to a boiler. The liquid is a chlorinated benzene compound that does not boil away.

If solar heat is to compete commercially with common fuels, it must be very efficient, and cheap to construct and operate. The inventor believes his heater can change 20 per cent of the sun's energy it receives into mechanical work—through a steam engine.

A five-horsepower engine would need the equivalent of 250 square feet of mirror. A series of mirrors and focus tubes would be used, instead of one large mirror that might blow over in a strong wind.

How does the sun influence the weather? Dr. Abbot reports his conclusions in a book to be published by the Smithsonian Institution later this year. If you are interested in a general forecast of precipitation in the United States up to 1967, be sure to read Dr. Abbot's book.

Change in Weight

The table of weights that your physician uses as a guide for how much you should weigh is in for some revision. New findings on body build, based on a study of the height and weight and general health of millions of persons, soon will be available. This will make obsolete the current tables, based on a study published nearly 30 years ago.

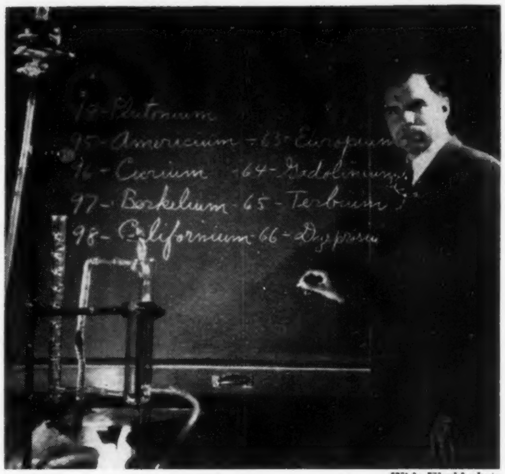
Arctic Ocean Barren

The Arctic Ocean has been found to be one of the most barren of the world's oceans. Although it comprises one twenty third of the area of all oceans, it contributes only about one thousandth of the total oceanic production of small plant and animal life, a basic food for larger marine life.

This conclusion is based on studies made during the International Geophysical Year. The studies involved measurement of the amount of photosynthesis taking place in the Arctic Ocean and of the concentrations of chlorophyll and nutrients.

today's scientists

GLENN T. SEABORG
Man Who Made Elements



By changing the arrangement of Periodic Table, Glenn Seaborg paved the way for the new elements.

Wide World photo

HOW to make new elements no man had ever seen. That was the challenge Dr. Glenn Seaborg faced. Specifically, his goal was the creation of new elements heavier than uranium—the heaviest element in nature.

Dr. Seaborg succeeded. Eight of the fourteen man-made elements were made by him and his co-workers. For this achievement he shared the Nobel Prize in chemistry in 1951 with Dr. Edwin M. McMillan.

The story of Dr. Seaborg's "science project" goes back to the 1930's, when exciting things were happening in atomic physics.

The first attempt to produce elements heavier than uranium was made by Enrico Fermi and Emilio Segre in Italy in 1934. They shot a stream of neutrons—neutral particles that appear in the nucleus of every element except common hydrogen—at uranium. They expected that these neutrons would be captured and thus transmute uranium into another (and heavier) element. Their attempt was unsuccessful.

Four years later came the first breakthrough. Otto Hahn and F. S. Strassman in Germany identified nuclear fission in 1938. They realized that an atom of uranium could fission or "split" into lighter elements and particles. In the process a great deal of energy was given off. But scientists throughout the world were puzzled by the problem of why neutrons shot into uranium atoms did not "stick."

Element 93 Is Found

At the University of California at Berkeley, Dr. Edwin M. McMillan followed up the experiments of Hahn and Strassman. He shot streams of neutrons at uranium oxide on a thin sheet of cigarette paper. In 1940 he found the first traces of a new element—element 93. He called the element "Neptunium," after the planet Neptune, the first planet after Uranus.

World War II had then broken out and the United States was building up its defenses. Dr. McMillan was called to work on radar. He turned over his studies of the elements heavier than uranium to one of his youngest and most brilliant co-workers—Glenn Seaborg.

Dr. Seaborg continued the search for new elements. In the 60-inch cyclotron at Berkeley he bombarded uranium with *deuterons*—hydrogen nuclei each containing a neutron and a proton—rather than simple neutrons. Protons are particles with a single charge of positive electricity.

At last element 94 was separated and identified. The first visible and weighable sample of the element was the size of a pinpoint. The new element was named plutonium, for the planet Pluto.

Changing the Periodic Table

That was in 1942, and many of America's scientists were hard at work trying to develop the atomic bomb. Plutonium could be used in the bomb, like the fissionable isotope of uranium. During the next year plants were built to produce plutonium. By the fall of 1944 plutonium was being produced on a workable scale. In the summer of 1945 the new element was used in the atomic bombs which caused the Japanese to surrender.

But Dr. Seaborg continued to hunt for elements even heavier than plutonium. However, a major theoretical roadblock faced him. When we list the elements in order of their atomic numbers, certain properties are found to recur periodically. In 1944 uranium, neptunium and plutonium were considered to be "cousins," although the family relationship was not clear. It was assumed from their position on the Periodic Table that elements 95 and 96 would have chemical properties very much like those of the three elements preceding them, and forming a "uranide group." But the assumption did not seem to be fruitful.

Then Seaborg conceived the idea that led to the discovery of all elements heavier than plutonium. Perhaps the radioactive elements were misplaced on the Periodic Table! Starting with actinium, the element of atomic number 89 that comes after radium, he placed the radioactive elements in a special row of their own. This was it!

The revised Periodic Table paired off the heaviest elements with the "rare earths." Rare earths are elements (atomic numbers 57 to 71) which are also listed in a separate row of their own. They are called "earths" because they resemble substances like lime and magnesia, which were once known as "earths."

Soon after Dr. Seaborg developed this concept, he carefully designed some very exciting experiments—to test it. Using his new concept Dr. Seaborg soon discovered Americium (95) and Curium (96). Four or five years after this, in 1949 and 1950, he discovered Berkelium (97) and Californium (98). He went on to discover Einsteinium (99) and Fermium (100). In 1955 he discovered Mendelevium (101).

The Night 101 Was Found

Dr. Seaborg can tell it best in his own words: "The synthetic elements have been discovered in pairs, so to speak. . . . After each pair of discoveries there was a period of mobilization of forces for the next search. The newly discovered elements had to be produced in appreciable amounts for transformation to the next stage. Techniques and instruments had to be refined.

"The most exciting episode," he relates, was "the night that element 101 was finally found. An atmosphere of gloom permeated the laboratory. In

(Continued on page 27)

tomorrow's scientists

Project: Construction of a Gas Chromatograph

Student: **John Allen**
South Salem Senior High School
Salem, Oregon
Science Achievement Awards Winner
Teacher: **George Birrell**

[Have you ever tried to separate the coins in a pocketful of change according to their denominations? You know this isn't difficult to do because the coins of each denomination differ from those of other denominations in some way. You use these differences to separate and thus identify each kind of coin. If you found something on a table and suspected it to be a mixture of salt and pepper, it wouldn't be too difficult for you to design an analytical method to prove your suspicions. A mixture of salt and sugar would be more difficult to analyze because these two materials are similar in most of their obvious characteristics. Analytical chemists, however, have become very clever in tracking down one or two characteristics which distinguish any one element or compound from all other elements or compounds.

John's project provides a good example of seeking a peculiarly identifying characteristic upon which to base analytical techniques. Since he worked with mixtures of gases, and many gases are quite similar in their properties, he had to rely on a rather subtle property. Keep watching for an explanation of this property as you read John's report.]

Gas chromatography attracted my attention because it is possible to analyze very small quantities of complex mixtures of gases with this process. This is a relatively new field of analysis and holds promise of yielding accurate qualitative (kinds of) and quantitative (amounts of) results.

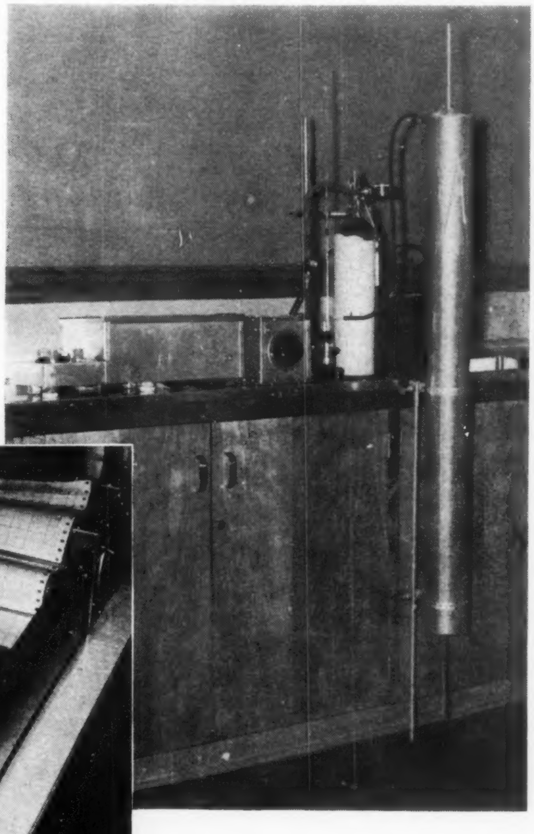
Gas chromatography is a fractionation process. The gas to be analyzed is caused to flow along a path which tends to separate the components of the gas.

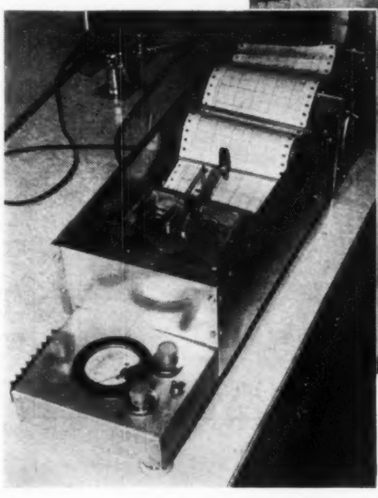
The two types of gas chromatography are adsorption and partition. Both types use a continuous flow of some auxiliary gas to carry the "unknown" gas through the analysis process.

In the adsorption type, the gas is caused to work its way through or along the surface of an adsorbent solid. In the partition type, the gas flows along a thin liquid layer which is supported on an inert solid.

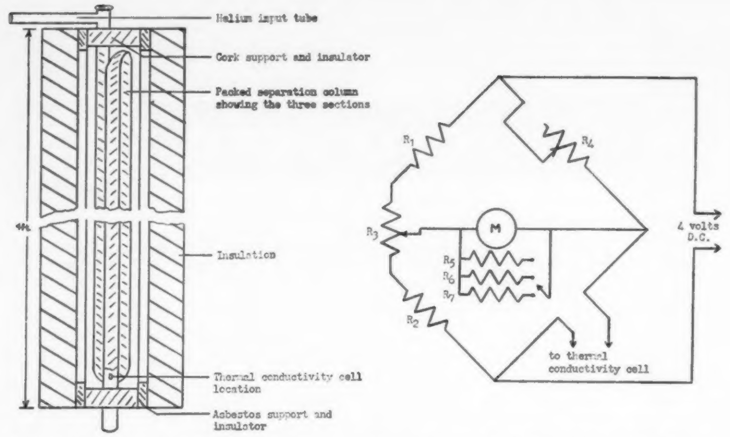
Both methods have their advantages and disadvantages. For example, in the adsorption type, active adsorbents readily lend themselves to the separation of highly volatile materials, but the strongly adsorbed materials are extremely difficult to remove from the adsorbent material of the stationary phase. Therefore, this form of separation column is definitely limited because the column can be used only a few times before regeneration (driving out these highly adsorbed materials under high temperatures) is required.

Award winner John Allen. Photo at right shows set-up of gas chromatograph. *L. to r.* Wheatstone bridge, recorder, transformer, needle valve, manometer, tank, battery, and the column.

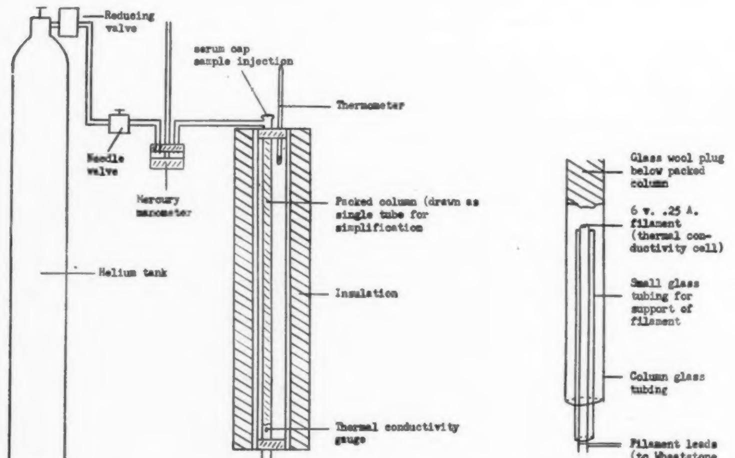




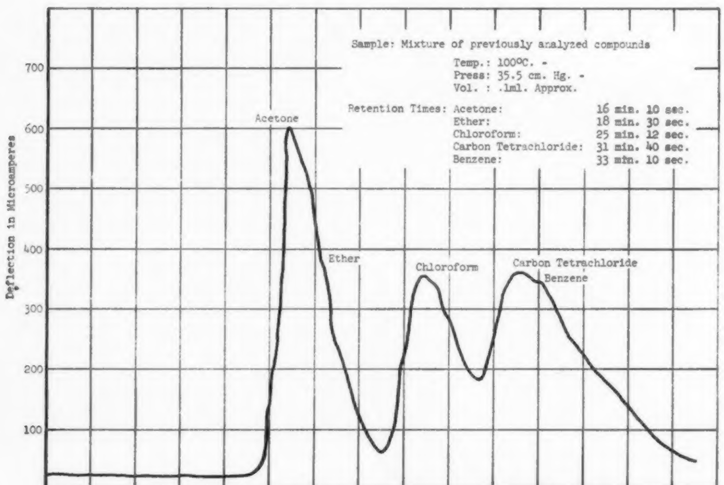
***(Left)*—Automatic recorder and Wheatstone bridge. This pneumatic pen recorder is still in experimental stage.**



Left—**Internal view of the 12-foot separation column showing triangular shape.** ***Right***—**Wheatstone bridge. R_1 and R_2 are 250 ohms, R_3 and R_4 are 25 ohm potentiometers for balancing. R_5, R_6, R_7, shunting resistances for microammeter.**



Left—**General Apparatus Diagram.** ***Right***—**Thermal Conductivity Cell.**



This graph shows an analysis of a mixture of previously analyzed compounds.

Because of its advantages, I chose to spend most of my time studying gas partition chromatography. The apparatus for this type of gas chromatography consists of a constant temperature separation column which is usually glass, copper, or stainless steel tubing with a fine-grain, inert solid packing material coated with a high molecular weight hydrocarbon oil. The oil provides the stationary phase, and for the mobile phase (the carrier gas) I preferred to use helium because it is completely inert and its flow could be carefully controlled.

The carrier gas enters the separation column at the sample injection point, thus "carrying" the sample through the stationary phase. The sample constituents are detected by a thermal conductivity gauge which is one arm of a Wheatstone bridge circuit.

In one of my first attempts, the separation column was a 12-foot section of ⅜" copper tubing coiled to conserve space. The stationary phase was vacuum pump oil supported on firebrick which had been crushed and sifted into fine particles. Placing the oil on the firebrick particles was accomplished by dissolving the oil in ether and mixing this solution with the solid material. When the ether evaporated, a thin layer of oil was left coated on the firebrick particles.

This column gave interesting results, but at the beginning of my second year of work on this project, I designed a new separation column using information in a pamphlet prepared by Dr. Eastman of Stanford University. This column was made of 8 mm glass tubing, 12 feet long. Because I didn't have the necessary equipment for working with pyrex glass, I arranged to have the column bent into three parallel sections in the glass-blowing laboratory at Oregon State College. I heated the column with a 250 watt nichrome heater which was surrounded by a dead air space.

For the stationary phase, silicone oil supported on Celite (diatomaceous earth) was used. The silicone oil has a very low vapor pressure. This was necessary because I expected to operate the column at a maximum temperature of around 150° C. I mixed the Celite and silicone oil the same way as when using firebrick and vacuum pump oil, except that chloroform was used as a solvent this time. The silicone oil equalled in weight about 15 per cent of the weight of the Celite. Compressed air, an aspirator, and a vibrator were used to fill the inaccessible parts of the column.

The thermal conductivity cell was made from a 6.3 volt, 0.25 ampere pilot light filament. The Wheatstone

bridge arrangement with the two thermal conductivity cell detecting devices —one closed off in a helium atmosphere and the other as the detecting device at the end of the column—is shown in an accompanying diagram. A constant voltage of 4 volts from a storage battery balanced the bridge and the unbalancing of the circuit was indicated by a 0-200 microammeter.

Means for sample injection was provided by a serum cap which was mounted at the top of the column. The sample of gas to be analyzed could be injected into the column by a hypodermic syringe with a one inch fine needle used to penetrate the serum cap. Finally, the carrier gas pressure was indicated by a manometer and held at an even pressure through adjustment of the reducing valve on the helium tank.

A trial run was made to provide data which would help me estimate how effectively components would be separated, the effects of temperature change, and of changes in carrier gas pressure. For this trial run, I used a temperature of 100° C., a helium flow pressure of 35.5 centimeters of mercury, and a 0.1 ml sample of carbon tetrachloride-acetone mixture.

Separation was indicated by unexpectedly large deflections of the Wheatstone bridge microammeter. The first deflection registered the first component at sixteen minutes after entry and lasted for seven minutes. During most of this time the reading was off scale. The second meter deflection, announcing the arrival of the second component, began at 32 minutes and lasted for 9 minutes. This indication also went off scale. These results clearly showed the ability of the column to separate a mixture of these two gases.

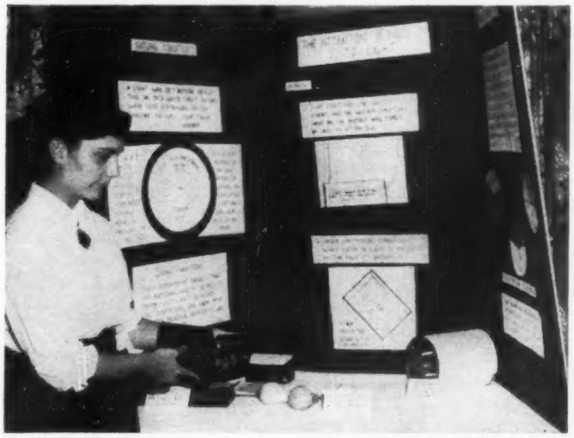
I am now in the proces of calibrating the column. This is done by running a large number of pure and labelled volatile organic compounds through the column separately at the same temperature and flow rate to determine their individual retention times. An unknown molecular mixture can then be qualitatively analyzed by referring the retention times of its components back to these data. Calibration curves obtained so far and the analysis of a mixture of several compounds are shown in one of the accompanying illustrations.

For the remainder of the school year, I plan to develop not only the qualitative aspects of my gas chromatography apparatus, but also the quantitative aspects. By measuring the area under the separation curve peak for a certain component, the amount of the component may be estimated. This and the freezing-out process will be attempted. In this process, I will freeze out a sample component when its presence is indicated by the gauge.

---

tomorrow's scientists

Project: Insect Phototropism



Ann Mayer and award winning project: Insect Phototropism.

Student: Ann Mayer

Fairborn High School
Fairborn, Ohio
Science Achievement Awards Winner

Teacher: Josephine Randall

[Have you ever noticed how some insects are drawn to light? Have you wondered which kinds are attracted most? Do certain colored lights attract more insects than do others? Does the weather have anything to do with attracting insects to a particular light?

Perhaps you can begin now, before winter sets in, to plan some experiments which will allow you to look into some of these questions.]

Phototropism, the response of living things to light, can be observed in many insects. While some are negatively phototropic, a great many have positive attraction to light. This research deals with positive phototropism.

The insects in the higher orders such as lepidoptera (moths, butterflies), diptera (flies, mosquitoes, gnats), coleoptera (beetles), and homoptera (plant lice, leaf hoppers, scale insects), may have as many as five eyes—three simple eyes or ocelli and two compound eyes. The work of these organs is, however, very limited. The simple eyes do not form images, but they do increase the sensitivity of the brain to light stimuli from the compound eyes. We know this because if the simple eyes are painted with an opaque paint, the insect does not react as rapidly to light.

One experiment proves that bees can distinguish various colors. A board was made with sixteen squares. All were colored different shades and colors, one of which was blue. On the blue square was placed a saucer of sugar water. Bees were then conditioned to go to the blue square. The bees went to the container for their food. Then all of the saucers were emptied, and the blue was moved to another location on the board. The bees still continued to go to the blue area.

The object of this set of experiments was to obtain a record of those insects that are most frequently observed at night lights in relation to (a) the color of the light, and (b) such weather factors as temperature, relative humidity, and barometric pressure.

THE LIGHT TRAPS

The equipment consisted of a sheet hung in my back yard with a light shining upon it. The sheet was 52 inches wide and 67 inches long. Its ends were caught up a yard from the ground. This was to prevent the insects from falling to the ground when they were brushed off. Pink, yellow, and white lights were used. An insect net was swept over the sheet to collect the insects that landed upon it. These were all killed.

The light was set out between nine and ten o'clock on three nights a week for four weeks. The three different colored lights were alternated. Records were kept of the temperature, relative humidity, and the barometric pressure.

Each night the insects were sorted into their orders and counted. A total was then made of all the insects caught.

TYPES OF INSECTS

The number and types of insects varied greatly with both the weather and the lights. It differed from 943 insects collected on one night to only 51 on another. The problem was to find out what caused this great variation.

One glance at my recorded data and I saw immediately that no matter what the weather was, what color light was used, or what other factors were taken into consideration, there were more diptera taken than all other insects combined. Of the 3,830 insects collected on twelve nights, 67.9 per cent of them belonged to that order.

The order to have the next highest number of insects, 8.9 per cent, is lepidoptera. Homoptera had 5.8 per cent, coleoptera had 5.7 per cent, and the remaining 21.3 per cent of the insects belonged to seven other orders.

The most important discovery made that was not directly connected with the lights is the fact that one of the first dermaptera to be recorded in the state of Ohio was collected during one of the nights. The specimen was taken to Mr. E. J. Koestner of the Dayton Museum of Natural History and its identification was confirmed.

On no two nights was the weather the same, and it is difficult to point out which type has the most important influence over the number of insects. In general, the insects seemed to prefer hot, humid nights with little wind.

TENTATIVE CONCLUSION

Because of the many factors involved, no true conclusion could be reached. The majority of the positive phototropic insects were attracted to white lights. Yellow and pink lights attracted few insects, although there were more with the pink light than with the yellow. The majority of the insects were diptera. The general trend of the insects seemed to be a tropism to white lights on hot, humid nights.

I could see that the only way to reach a true conclusion was to conduct controlled experiments. The second part of this research was designed for this.

NEED FOR CONTROL

It was brought out in the first part of this report that setting out lights and keeping records of weather and number of insects attracted to the lights provided very little sound information. A controlled experiment, although it would limit what I could find out, had to be arranged. By conducting the experiment inside, the weather would remain a constant factor. It was necessary to control the insects involved, that is, to select one insect. This research would have no connection with weather factors or even the number of different insects attracted. The ONLY purpose would be to study the phototropism of the insects chosen.

Although it is small and is not nocturnal, the fruit fly had several advantages. First, specimens could be obtained easily from supply houses. Secondly, they reproduced every ten days and it would be easy to keep enough for all the experiments. A pure strain of red-eyed Drosophila was selected.

EQUIPMENT

All the equipment for these experiments can be made from simple materials. The general idea was to shine a plain white light through a cellophane slide. The light was mounted inside a can. A Drosophila was placed in a small jar, which had a black piece of paper around half of it. In the front of the paper, in the center, two slits were made. Each was three eighths of an inch wide and five eighths of an inch long. A piece of colored cellophane was placed between the jar and the paper.

The flies were kept in individual containers. Baby food jars were used for this purpose because they were easy to obtain. Some jars had from eight to ten flies in them so that they could reproduce. Only those used for the experiments were kept separate. Food for the flies was made from agar-agar, corn meal, corn syrup, water, and yeast. The Drosophila laid their eggs in this and the larvae ate and lived in the media.

THE PROCEDURE

To determine the tropism of the Drosophila to the light colors, they were placed in individual jars. The fly was then given a choice of white and yellow, white and purple, or yellow and purple light. A fly was used for only one experiment so that it would not become conditioned to a certain color.

When the light was turned on, the fly had to go back and forth between the colors five times. If a fly went to a white light, it was called a "white," and when it went to a yellow light, it was called a "yellow," etc. In order for two "whites" to be recorded in succession the fly had to leave the preferred light and go to another part of the jar. Also, to be recorded, the fly had to walk directly across the beam of light. The fly was kept in this jar until five changes were completed.

After a set of five changes were made, a new fly was used. For each color combination two hundred experiments were completed. These experiments were divided into halves. One half had one color on the left and the other on the right. For the other hundred experiments the sides on which the light appeared were reversed. Thus, with all of the arrangements possible for these three colors, a total of six hundred experiments were performed.

RESULTS

Drosophila had no preference for either side of the jar. With the white-yellow combination 70 per cent preferred white when it was on the left and 67 per cent when it was on the right. The purple-yellow lights showed a tropism of 28 per cent to purple when it was on the left and 37 per cent when it was on the right. White-purple experiments showed that when purple was on the left 40 per cent went to it and when it was on the right, 48 per cent. This variation, was not important enough to be considered.

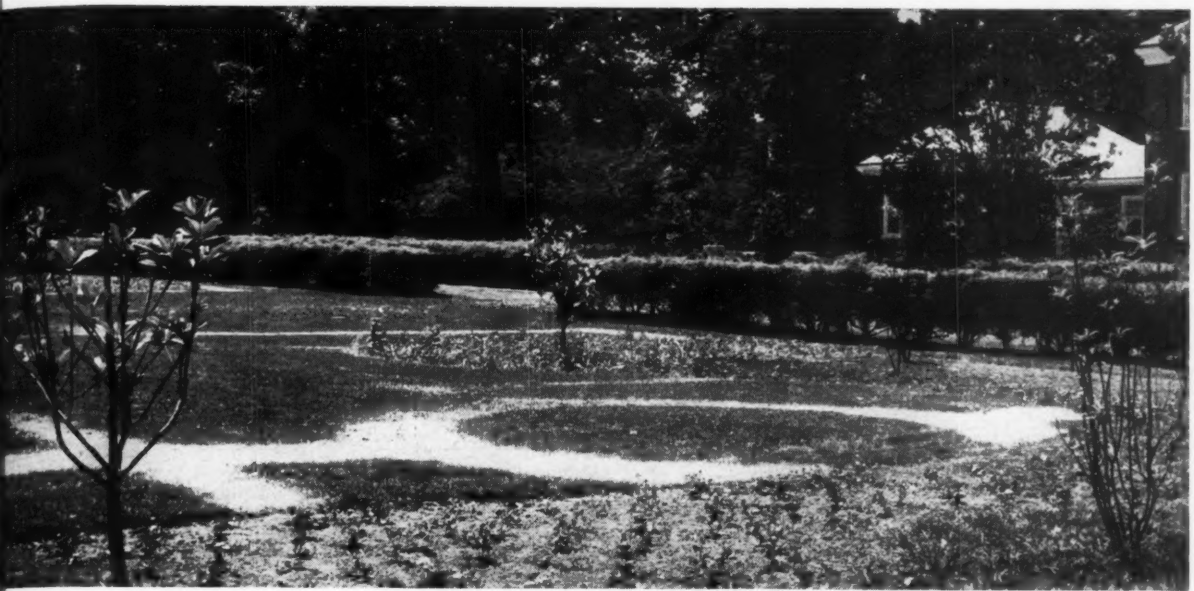
For the white-yellow combination 70 per cent of the Drosophila were attracted to the white. These two colors showed the greatest difference. The purple attracted 66 per cent of the Drosophila. There was less difference between the purple-white combination than the others. Only 57 per cent went to the white light, whereas 70 per cent had preferred white to yellow.

Thus, from these experiments we now know that the Drosophila definitely has a stronger tropism toward white than to yellow. It was determined that there was also a greater attraction of the insects to purple than to yellow, and that to a certain extent, white light attracted more Drosophila than purple.

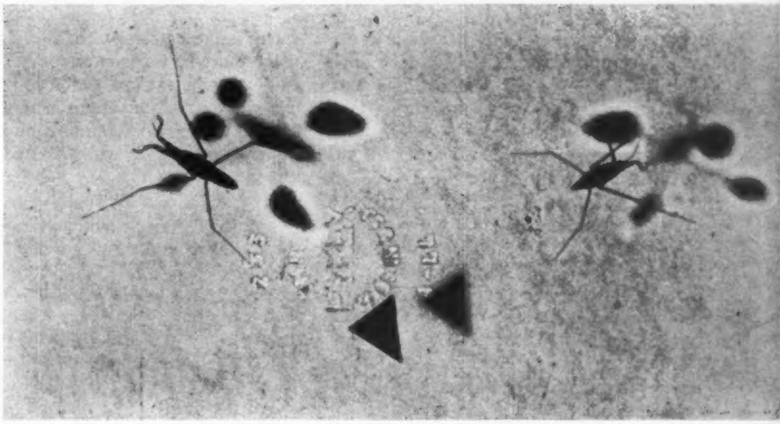
EVALUATION

These experiments as a whole proved very little that can be put to a practical application that has not already been used. Since pure research, by definition, has no practical value by itself, it is understandable why there is no useful application as part of my results. There is a great deal of work left to be done in this field, however, and some of it could lead to many new uses. Very little is yet known about what colors insects are capable of distinguishing, especially the wave lengths not visible to the human eye (*e.g.*, ultraviolet and infrared). Continued work on this subject could develop into something truly worthwhile. Thus, the research that I have done is only the beginning of a study of a vast field of research.

Curiosity Catchers



What was responsible for the pattern of brown, burned grass in the photo above? Was it the wrong weed killer? Was too much fertilizer used? Or did drought cause the pattern?



Have you ever noticed shadows cast by water striders? Have you wondered why their needle-like feet cause such large, round shadows, whereas their bodies have body-size shadows, and leaves that you may find floating on the same stream will cause leaf-size shadows?

HAVE you noticed that car radios sometimes fade out or become silent while you are crossing a bridge? Why is this? Does it matter what kind of bridge it is, or where the broadcasting station is in relation to the bridge?

Why should the picture on a TV screen flicker when an airplane goes by overhead?

Oil spots on wet pavement sometimes show all the colors of the rainbow? Why?

Can the commonplace excite your curiosity? The things that catch your curiosity may not lead to important discoveries. But you will find that a well exercised curiosity can give more interest to the whole business of living.

To give you some of the fun of exercising your curiosity, *Science World* includes in each issue some Curiosity Catchers, things we hope will arouse your curiosity and spark it into planning experiments and investigations with the other members of your class.

For the science class that sends in the best plan of attack for following up each Curiosity Catcher, *Science World* will award a science reference book for the classroom shelf—a book of your choice!

Each class entry must be postmarked not later than 30 days after the date of the issue in which the Curiosity Catcher appeared. Address your entry to Curiosity Catchers, *Science World*, 33 West 42nd Street, New York 36, N. Y. Entries will be judged on how clearly the problem is worded, on how much additional information has been brought together, on the probable fruitfulness of hypotheses, and on the strategy with which experiments or investigations are planned or carried out.

Meeting the Test

Using the "Big Ideas" of Science

By THEODORE BENJAMIN

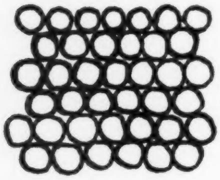


Fig. 1. Two-dimensional drawing shows how the atoms pack in a single crystal.

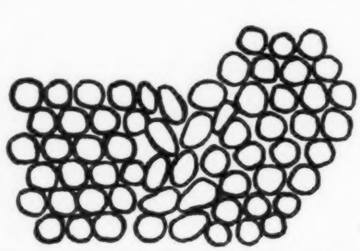


Fig. 2. Drawing illustrates dislocations in metal. Note the atomic structure.

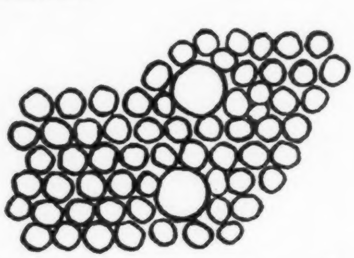


Fig. 3. An "alien" atom in an alloy may hinder movement of dislocation.

KNOWLEDGE of an isolated fact holds little value if we don't recognize how that fact fits into and is related to other facts. On the other hand, the understanding of a "big idea" of science can stand you in good stead in answering a large number of questions.

Let us give you an example of exactly how powerful an understanding of a "big idea" in science can be. The following paragraphs deal with some of the latest thinking in the physics of metals. Read them carefully. Look up meanings of words you may not understand. Then see how successfully you can apply the theory to answering the questions which follow.

To understand the properties of metals we must consider the nature of the atoms of metals and the forces holding these atoms together.

If you look at a periodic chart of the elements, you will notice that all the elements in the first three columns of the periodic chart (except hydrogen and boron), all the long period transition elements, and all the lathanide and actinide elements are metals. If you examine the atomic structure of metallic elements you will find that almost all have three or fewer electrons in their outermost (or valence) electron shell.

Four Types of Bonding

In solids there are four principal types of bonding, or ways in which adjoining atoms are held together. In solidified "rare" gases such as helium, neon, etc., we find the "Van der Waals bond." This bond results from a weak attraction which exists between the completed outer electron shells of such atoms.

Ionic bonding occurs when a small number of electrons are transferred from the shell just outside the completed shell of one element to another element which needs them to complete its own outer shell. For example, in rock salt (NaCl) each sodium atom gives up its one electron in its outer shell to complete the outer shell of a chlorine atom. The solid is held together by the electrical attraction between the resulting positive sodium ions and negative chlorine ions.

In the covalent bond, atoms attain complete shells by sharing electrons rather than by transfer. This type of bond occurs when all the atoms involved are reasonably close to having full shells. In quartz (SiO_2) each silicon atom shares an electron with each of four oxygen atoms and each oxygen atom shares one electron with each of two silicon atoms. Since there is no electron transfer, each atom remains electrically neutral and the bonding is due to the shared electrons.

In a metal neither ionic nor covalent bonds can form because none of the atoms has enough valence electrons in its outermost shell to be close to having a full, closed outer shell. Instead, all the atoms contribute all their valence electrons to a general pool shared by them all. One may regard a metal as an array of metal ions in a sort of gas of electrons which may move freely throughout the whole piece of metal. The metallic bond is due largely to the electrostatic interaction between the positive metallic ions and the negative charge of the electrons.

To make the electrostatic attraction between ions and electrons as great as possible, metallic atoms pack together as closely as possible. Fig. 1 shows a two dimensional view of how the packing is done in a perfect crystal of metal. Perfect crystals are rare. In most cases the packing exhibits irregularities or imperfections which are called dislocations. Fig. 2 shows such a dislocation.

Metals can be bent without breaking because these dislocations can be formed and moved relatively easily within the metal. Dislocations also occur in ionic and covalent crystals (such as rock salt and quartz) but they cannot move easily at low temperatures. In such crystals the strong attractions hinder movement or anchor dislocations.

In an alloy, which is a combination of two or more metals, one of the metals may have smaller atoms than the other. The large atoms are arranged as in a pure metal. The smaller atoms fit into the spaces between. A good example of this so-called interstitial solid solution is steel, in which the small atoms of carbon fit between the atoms of iron. If the two kinds of atom are about the same size, one atom of one kind must be removed to make room for each atom of the other kind. Brass, for example, is a substitutional solution of zinc in copper (Fig. 3).

Explanations Wanted

In the light of the foregoing theory see how well you can do explaining each of the following:

1. Metals conduct electricity better than non-metals.
2. Heating a metal increases its electrical resistance.
3. Heating a non-metallic solid decreases its resistance.
4. Metals conduct heat better than non-metals.
5. Copper bends more readily than brass.
6. Good electrical conductors are good reflectors of light, while the best insulators are transparent or translucent.
7. A metal can be hardened by beating it (work hardening).
8. Putting excessive stress on a metal rod bends it. Putting excessive stress on a glass rod breaks it.
9. Bending a rod of metal made of a single crystal is easy, but unbending it is considerably more difficult.
10. Helium, neon, argon, etc., have low melting points.

Answers are on page 28.

Man Who Made Elements

(Continued from page 20)

the attempt to produce and identify element 101 we had carried out a number of very careful experiments, and all had failed. Now a last experiment was being tried, on the basis of what seemed only a far-fetched possibility."

The tiny sample produced might contain one or two *atoms* of the elusive element 101—at best. Dr. Seaborg goes on: "There was some reason to believe that an atom of element 101 might decay in an hour or two into an atom of element 100, which in turn might break up spontaneously by the fission process. If this barely possible combination of events took place, the creation of element 101 would be signaled. . . . We watched with eyes fixed on a pulse recorder. . . . An hour went by. The night dragged on toward dawn. The waiting seemed interminable. Then it happened! The recorder pen shot up to mid-scale and dropped back, leaving a neat red line which represented a large ionization pulse." (Ionization occurs when an atom is stripped of an electron and becomes electrically charged.)

Atomic Prospector

"The vigil continued," says Dr. Seaborg. "An hour or so later the pen recorded a second pulse like the first. We were now confident that we had witnessed the decay of two atoms of element 101—and had added a new member to the roster of chemical elements."

Elements 94 to 101 were ushered into the world by Glenn Theodore Seaborg. When he was born 47 years ago in Ishpeming, Michigan, the people of the little mining town little dreamed that he would be prospecting some day in a world as tiny as the atom.

Answers to Crossword Puzzle

(See page 31)

A	O	R	T	A	■	■	■	B	R	I	N	E
N	■	■	C	C	V	■	O	R	E	■	■	N
I	C	E	■	I	■	■	■	A	■	E	R	A
M	A	P	■	D	C	■	B	D	■	R	I	M
A	V	E	S	■	A	A	A	■	B	I	L	E
L	E	E	■	G	L	A	N	D	■	E	E	L
■	■	■	S	A	C	■	T	I	P	■	■	■
L	A	B	■	B	I	F	I	D	■	S	A	P
I	R	O	N	■	U	R	N	■	C	E	L	L
S	I	N	■	A	M	■	G	O	■	E	T	A
T	A	E	■	N	■	■	■	P	■	D	O	S
E	■	■	A	T	E	■	P	U	S	■	■	M
R	O	O	T	S	■	■	■	S	T	O	M	A

Project and Club News

Tips for Science Fair Exhibits

COLOR is one of the most important ingredients of an exhibit. In selecting your color, avoid gaudiness. Let one pastel shade dominate your exhibit. This approach will unify a design. When you wish to emphasize a small area, use a contrasting color or dark tones of the background color.

There are certain colors which add to the theme of an exhibit. Thus green is a natural color for agricultural displays; pale blue with a limited amount of white is best suited for a medical exhibit.

Use enamel paints or lacquer for backgrounds and bases. Poster colors and water colors are excellent for illustrations. Poster colors also are easy to use for large lettering.

Poor lettering frequently causes the downfall of many science fair exhibits. By using care, you can achieve a professional result.

Keep your wordage brief. Should you require extensive wordage, use a booklet attached to the exhibit for your explanation. Remember that clarity is essential.

Headings or titles of exhibits should be prominently lettered. Any additional reading material should be of a reduced size. Since viewers tend to resist reading fancy, decorative copy, select a plain letter style.

Proper lighting can be used to make an exhibit more appealing to the eye of the viewer. Direct glare and harsh reflections make viewing difficult.

You can make a light baffle of masonite. Construct a long, small box with an open side. The open side will contain showcase bulbs and sockets. Allow more than one inch clearance between the bulb and the masonite to avoid burning. The interior of the box can be painted white to serve as a reflective surface. The exterior can be painted the dominant color of the exhibit to appear inconspicuous.

Use durable, lightweight material for bases and backgrounds. Interesting effects can be achieved by using textured plywood or masonite for exhibit backgrounds. Textured plastic sheets, self adhering, can be applied over other construction materials for color and simulated texture.

Future issues of *Science World* will contain more exhibit tips. Watch for them.

Will the Search Find You?

If this is your senior year of high school, you are eligible to enter the Science Talent Search for the Westinghouse Science Scholarships and Awards.

A Science Aptitude Examination and personal and school record forms for each entrant will be mailed out to teachers on or about November 15 by Science Clubs of America. The exam may be given by your teacher or principal any time between December 1 and December 27.

All the materials, including your paper of about 1,000 words on your research project, must arrive at Science Clubs of America (1719 N Street, N. W., Washington 6, D. C.) by midnight, December 27.

An Honors Group of about ten per cent of the fully qualified entrants will be chosen for special recognition, certificates, and recommendations to the colleges they hope to attend. Such recommendation usually results in admission and often in scholarships.

Forty winners will be selected from the Honors Group to attend the five-day Science Talent Institute to be held next spring in Washington, D. C., with all arranged expenses paid. During the Institute the winners will meet some of the nation's most distinguished scientists, visit world-famous laboratories, and get to know the other 39 "kindred souls" that make up the Top Forty. They also will be interviewed by the judges for the awarding of $34,250 in scholarships and awards.

The five Westinghouse Science Scholarships are for $7,500, $6,000, $5,000, $4,000, and $3,000, with one fourth of each scholarship being paid each year for four years of college. The remaining 35 winners each receive a Westinghouse Science Award of $250.

If your senior year is still ahead of you, you have a wonderful chance to start right now on a long-term, fully developed research project. And you can practice on previous years' aptitude examinations. (Send for them to Science Clubs of America—15¢ each. Answers are included.)

Ask your sponsor or your principal to let you borrow "How You Can Search for Science Talent." This is a booklet prepared each year by Science Clubs of America. In it you will find information, rules, and abstracts of some of the winners' project papers. (Booklets of four previous years can be purchased for 50¢ a set.)

Prepare now for the Science Talent Search. The Search is looking for you.

Answers to Meeting the Test

(See page 26)

1. Under the influence of an electric field (battery) the electron "gas" flows freely through a metal. This flow is an electric current. All electrons in a non-metal are rigidly held in place. Therefore, nonmetals do not conduct well.

2. As a substance is heated the atoms of a solid begin to vibrate. This interferes with the movement of electrons through the metal.

3. Heating, which causes vibration of atoms, frees some of the rigidly held electrons. Under the influence of a battery these move through the substance giving rise to a small electric current.

4. If one end of a piece of metal is heated, the electrons in that end acquire extra energy, and when they travel around in the metal they carry that energy with them, thus distributing it throughout the piece. This method of heat transmission is far more rapid than the vibrations of the atoms themselves, which is the principal mechanism of conducting heat in nonmetals.

5. Atoms of zinc are somewhat larger than atoms of copper. The zinc atoms tend to hinder movement along dislocations in brass, thus making the bending of brass (a zinc-copper alloy) more difficult than the bending of a similar rod of copper.

6. Light waves striking the relatively loose electrons in a conductor set them into vibration. They re-radiate the light thus giving rise to reflection. The tightly held electrons of the insulator are not set into vibration. Therefore the light moves through.

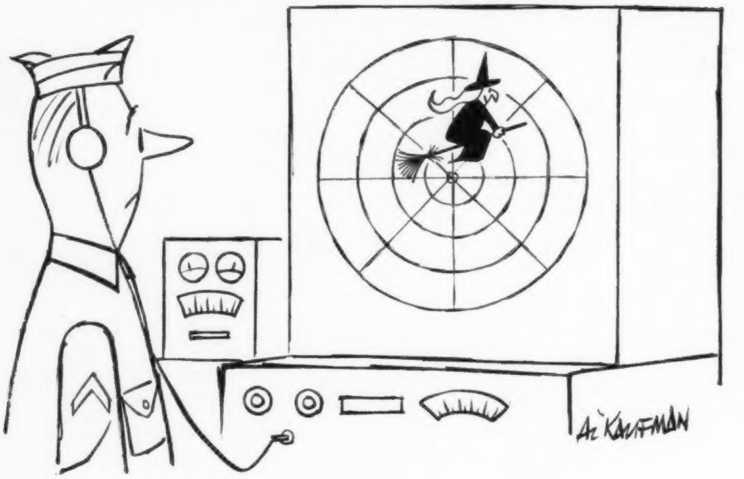
7. As a metal is beaten the number of dislocations increases. If a metal with a large number of dislocations at random angles to each other is subjected to stress it will not bend readily because motion along one dislocation will interfere with motion along another.

8. In metals movement along dislocations is relatively easy. In non-metals attraction between atoms is an all or none proposition.

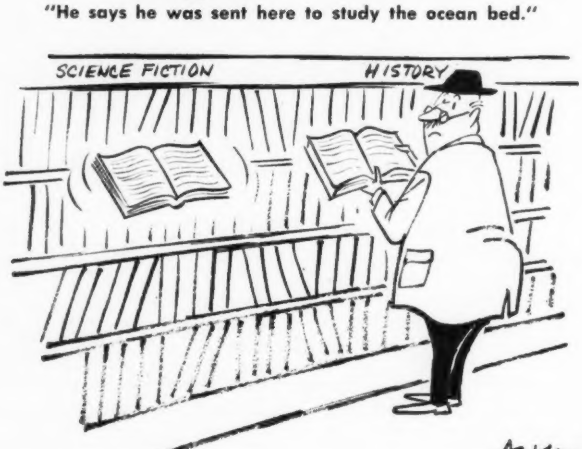
9. As bending of a single crystal progresses, dislocations are introduced. In trying to unbend the bar the presence of a large number of dislocations interferes with and opposes the motion.

10. The weak attractions between such atoms, which have closed shells, is not conducive to forming solids if the atoms have any appreciable thermal motion.

sci-fun



"He says he was sent here to study the ocean bed."



Science Bookshelf

HIDDEN AMERICA, by Roland Wells Robbins and Evan Jones (Knopf, New York, 1959, 259 pp., $5.00.)

Many landmarks of early America lie buried in your own back yard or town. This book conveys the excitement of archaeological discovery.

Robbins, a successful pick-and-shovel historian, in collaboration with Evan Jones, a journalist, tells how he has applied the techniques of archaeology to the rediscovery of some lost landmarks. Some of his "finds" include Viking encampments on Cape Cod, an early Du Pont powder mill, the first assembly line in America, and the much debated Kensington Rune Stone.

High school students helped Robbins excavate the first iron works on the Saugus River in Massachusetts. Wherever Robbins has worked he has found young people eager to help.

In the early 1940's, Robbins began to make a hobby of digging for the buried facts of local history. The hobby soon became a full-time occupation. He is now recognized as a professional archaeologist.

The book is well illustrated with photographs and maps. Considerable space is devoted to discussion of equipment. An important tool is a probe rod with a T-bar handle at one end and a sharp tapered point at the other.

No one can read *Hidden America* without becoming excited about the history waiting to be uncovered. In the United States, there is enough to keep diggers busy for generations.

THE SKY OBSERVER'S GUIDE, by Newton Mayall, Margaret Mayall, and Jerome Wyckoff (Golden Press, New York, 125 pp., $2.95.)

Astronomy is front-page news, and people are looking skyward. Many are training newly acquired binoculars and telescopes on the heavens.

This book is for those who want to *look*. Much practical information has been packed into it.

The authors encourage the amateur to study the skies. They point out that a high school student's faithful observations of a variable star may be just the data an astronomer at a large observatory needs.

There are tables of planet locations, coming eclipses, and recurrent meteor showers. Some ten pages of colored maps show locations of constellations as well as other important bodies, and indicate the best times of year for observing them.

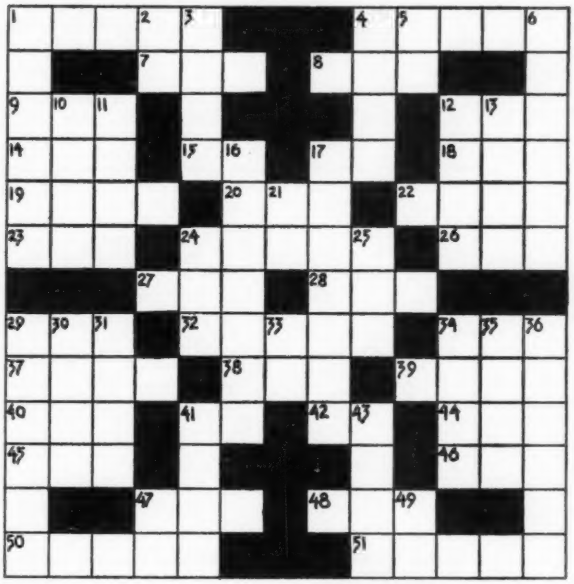
—Lavinia Dobler

Living It Up and Down

By Anthony Saffarano, La Salle Academy High School, New York City

★ Starred words refer to biology

Students are invited to submit original crossword puzzles for publication in *Science World*. Each puzzle should be built around one topic in science, such as astronomy, botany, geology, space, electronics, famous scientists, etc. Maximum about 50 words, of which at least 10 must be related to the theme. For each puzzle published we will pay $10. Entries must include puzzle design, definitions, answers on separate sheets, design with answers filled in, and statement by student that the puzzle is original and his own work. Keep a copy as puzzles cannot be returned. Give name, address, school, and grade. Address Puzzle Editor, Science World, 33 West 42nd Street, New York 36, New York. Answers to this puzzle are on page 27.



ACROSS

*1. Large artery carrying blood from the left ventricle.
4. Water strongly saturated with salt.
7. Roman numeral 205.
8. Homonym for or.
9. Frozen H_2O.
12. The Paleozoic ________ began 500 million years ago and lasted 300 million years.
14. Drawing of the Earth or part of it.
15. Direct current (*abbr.*).
17. Bachelor of Divinity (*abbr.*).
18. Outer part of a wheel.
*19. Class of the phylum Chordata consisting of the birds.
20. Amateur Athletic Association (*abbr.*).
*22. Yellowish secretion of the liver.
23. He led Southern forces in Civil War.
*24. A hormone is the secretion of a ductless ________.
*26. A long, slimy, snake-like fish.
*27. Bag-like part of a plant or animal.
*28. Where on a root is the rootcap?
*29. Place for biology experiments (*abbr.*).
*32. Divided in half by a cleft; forked.
*34. The circulating fluid of plants.
*37. Hemoglobin contains ________.
38. A vessel or vase.
*39. A mass of protoplasm made up of a nucleus and cytoplasm.
40. An offense against divine law.
41. First person singular of verb to be.
42. "Easy come, easy ________."
44. Estimated time of arrival (*abbr.*).
45. Inventor of phonograph (*initials*).
46. Author of *U. S. A.*, ________ Passos.
47. Past tense of eat.
*48. Fluid at site of infection.
*50. In plants the ________ absorb water and minerals.
*51. Through this opening on a leaf a plant takes in carbon dioxide.

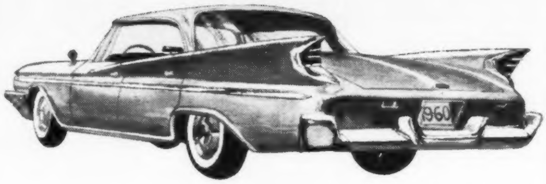
DOWN

*1. Man belongs to the ________ kingdom.
2. Technetium (*chemical symbol*).
*3. An amino ________ is the end product of protein digestion.
4. A thin nail.
5. In music the second note in the diatonic scale.
*6. Hard, calcareous, outer layer of a tooth.
10. The prehistoric ________ man lived during the Stone Age.
11. Thin, pointed sword without a cutting edge—used in fencing.
12. Lake ________ is between Lake Huron and Lake Ontario.
13. Irritate, vex (*colloq.*).
*16. Diets rich in ________ are necessary for strong teeth.
*17. He discovered insulin in 1921, Sir Frederick ________.
21. Associate of Arts (*abbr.*).
24. Chatter (*colloq.*).
25. "________ you ever see a dream walking?"
*29. Englishman who introduced antiseptic surgery in medical practice, Joseph ________.
30. Melody sung by a single voice in an opera.
*31. The femur is a ________ located in the upper leg.
33. Francium (*chemical symbol*).
*34. A fertilized, ripened ovule.
35. Musical part sung by the lowest female voice or highest male voice.
*36. Fluid part of the blood.
*41. Insects that live in underground colonies.
43. You can tell the chronological order of a composer's work by the ________ number.
47. Astatine (*chemical symbol*).
49. Street (*abbr.*).

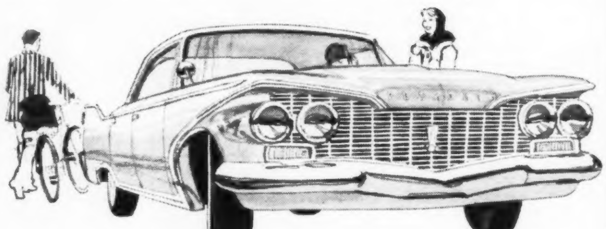
The New 1960 cars from Chrysler Corporation

—How to spot them from any angle

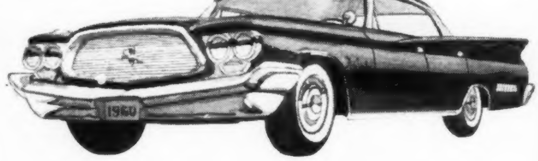
Wind tunnel tests helped Chrysler Corporation engineers develop basic car shapes that cut wind drag and improve handling. Our top automotive stylists took this true aerodynamic design and added some special finishing touches of their own. Result? Pure automobile—the most distinctive cars on the road. Here are just a few of their unique "ID cards" . . .



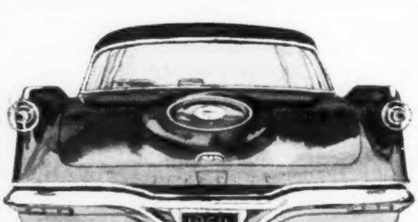
1960 DE SOTO . . . A long, gently curving flow of metal, like the vane on a missile, from taillight to fender-front.



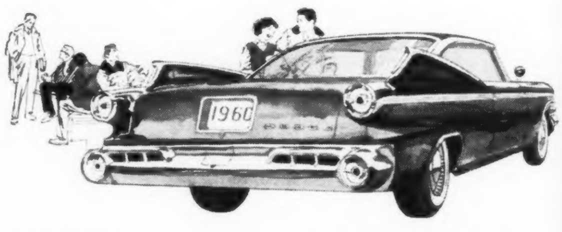
1960 PLYMOUTH . . . Air-scooped fender insert, outlined by a whiplash arc that sweeps from wheel opening to hood.



1960 CHRYSLER . . . Classic, racing-car grille brought up to date. In the rear, flying V taillights.



1960 IMPERIAL . . . The famous gunsight taillights. Massive, low-slung bumper with a wide longhorn curve.



1960 DODGE . . . Double-barrelled taillight and back-up light sets flank the broad, sleek expanse of the rear deck lid.

1960 DODGE DART . . . Clean, taut lines flowing from the backswept grille to the trimly sculptured rear fender.

And watch for Valiant, Chrysler Corporation's new economy car . . . coming soon.

The Quick, the Strong, and the Quiet —the all-new ones for 1960 from

CHRYSLER CORPORATION

space, radio technology came to be applied to astronomy. The article tells of Jansky's discovery, describes some of the fantastic "ears" being fashioned and turned toward the skies, and indicates the significance of some of the signals being received by radio astronomers. The article points up the uses being made of radio telescopes and radar telescopes in tracking man-made as well as natural satellites.

Topics for Class Discussion

1. How Karl Jansky came to discover radio noises from outer space.
2. Why a radio telescope is shaped as it is.
3. A collision of heavenly bodies revealed by radio telescope.
4. Famous radio telescopes of today.
5. Radio telescopes and radar telescopes.
6. What new radar telescopes now being built will be able to do.
7. A "home-made" radio-telescope.
8. How radio telescopes penetrate cosmic dust clouds to make "observations" that cannot be made optically.
9. Radio telescopes pick up radio waves half a billion years old.
10. Radio astronomy, newest branch of one of the oldest sciences.
11. How information on solar radio bursts could lead to a deeper understanding of the physics of very high temperature gases in magnetic fields.

Tomorrow's Scientists (pp. 21-24)

A Gas Chromatograph

The use of paper and column chromatography and of electrophoresis to separate complex mixtures in solution has yielded dramatic information in a wide variety of investigations in recent years.

Now comes John Allen with a device of his own design to separate mixtures of *gases*. He describes this device in great detail and indicates the steps he took, and further steps he is planning to take, to improve it.

The details of his separation column will interest bright students in both physics and chemistry classes. Physics students will be particularly interested in the design and use of his thermal conductivity cells.

Insect Phototropism

An interesting feature of Ann Mayer's project is this: it began as a *field* study that involved the study of many insects under complex conditions. This study produced data that were complex and inconclusive. But out of this study emerged the idea for a laboratory experiment of careful design and involving controlled conditions. The young lady carried out her investigations in the laboratory diligently and with admirable perseverance. She came out of her experimentation with some interpretable information gleaned from Nature. But what is more important, she came out with a vision of "a vast field" for further exploration and research.

All this makes Miss Mayer's report almost an ideal example to hold up to the class that is being introduced to the nature of project work, to illustrate the qualities it takes to follow through, and the adventure of research.

Ann Mayer's report would also make interesting reading for a biology class studying a unit on animal behavior.

Tips for Science Fair Exhibits (p. 28)

It is not too early in the school year, even now, for teachers and students to begin thinking about science fairs, for participation requires much advance planning. Tips for Science Fair Exhibits will therefore come in handy for you to bring to the attention of your students preparing exhibits, and it will serve to answer many questions on what to do and how to do it that students would otherwise bring to you. The attractiveness and effectiveness of many an exhibit in forthcoming fairs will be enhanced if the tips here provided are taken into account.

—ZACHARIAH SUBARSKY

Nutrition—Stanch Ally of Medicine (pp. 13-15)

Biology Topics: Nutrition, physiology, scientific method
Chemistry Topic: Chemistry of foods
Home Economics Topic: Changes in our diet

Teaching Suggestions

This article affords the teacher an opportunity to discuss a topic in which girls have an inherent interest—food. It will be part of their "job" as future homemakers to know which foods provide the "most" in nutritional value. Using this approach as your motivation, discover with the class the importance of an adequate diet.

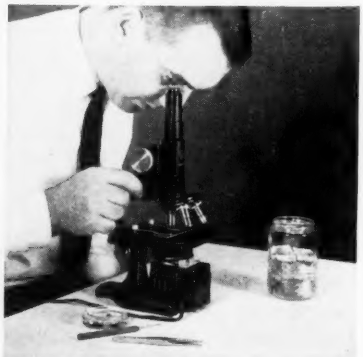
A rat-feeding experiment is a vivid example of the importance of a proper diet. The experiment may be used in two ways: (1) as the starting point of a study of foods or (2) as an example of what has already been learned. It also illustrates the scientific method in action. The experiment will take about seven or eight weeks. Rats may be obtained from health departments in some states, Sprague Dawley, Inc., Box 2071, Madison 5, Wisconsin, or Agricultural Experiment Stations of State Universities. Do not use "pet shop" rats.—S. S.

AO Reports on Teaching with the Microscope

Husbandry of Molds or Gentleman Farming in the Classroom

By: Mr. William Altfeld
New York School of Printing
New York, New York

This unique experiment is reproduced exactly as submitted by Mr. Altfeld. He has used it, with much success, in his general science classes at the New York School of Printing. We submit it to you as a fine way to introduce students to the study of microscopic common, non-green plant life, as well as to the importance and use of the microscope in biology. In a very simple way, it extends the field of microscopic creativity by utilizing ordinary, "everyday" materials...indeed, the dust from the very air that surrounds us.



Mr. Altfeld suggests using the AO Spencer No. 66 Compound Microscope. He didn't have to say that...but we are not unhappy that he did. You see, we know the AO No. 66 combines superb optical performance with rugged construction...is designed to service even the most active class. Full facts on the AO No. 66 are yours for the asking. Just write American Optical Company, Instrument Division, Dept. V252, Buffalo 15, N. Y. Complete information will reach you by return mail.

EXPERIMENT

Growth and microscope study of our common molds.

MATERIALS AND PREPARATIONS

1. AO Spencer No. 66 Compound Microscope with 10X eyepiece and 10X and 43X objectives.

2. A microscope lamp is also a worthy accessory.

3. Box of clean slides and cover slips.

4. Tweezers and teasing needles.

FOR THE MOLD CULTURES THEMSELVES

1. Thoroughly cleaned food jars with twist off caps e. g. those used for jam, peanut butter, mayonnaise etc:

2. Squares of stale bread (cut down to 1"x1");

3. Newspaper;

4. Water;

5. Normal dust from the air.

PROCEDURE

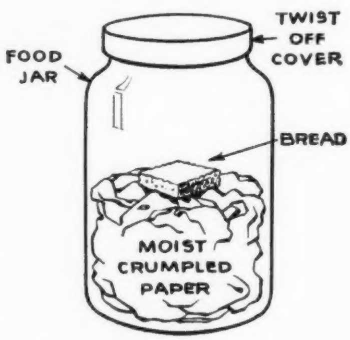
1. Crumple a small handful of newspaper.

2. Sprinkle (do *not* soak) the newspaper with water until it is damp, but not limp.

3. Place the ball of damp paper into the bottom of a cleaned food jar (Fig. 1). With the cover on, this will provide a moisture chamber essential to the germination of mold spores.

4. Take a 1" x 1" square of stale dry bread and rub one side of it along a dusty surface of a table.

5. Carefully insert the square of bread into the prepared jar with the dusty side up.



6. With the cover of the jar replaced, the culture is now placed in a dark, warm, part of the room for several days.

7. A variety of colorful molds may be the reward for the careful mold gardener. However, the most common bread mold, Rhizopus nigricans...a black mold with cottony mycelia will tend to steal the show.

8. After the molds have made their appearance, we can open our jars, and prepare to delve into the tiny world with the microscope.

9. With tweezers we snip off a sample of our common black mold. Place the sample on a clean slide into a drop of water. With teasing needles we separate the mass of hyphae. Then we prepare a temporary mount with a cover slip.

Photomicrograph of an Aspergillus

10. We now examine under 100X of the microscope for an over all view of the hyphae with their spore cases. Under higher power, 430X, we can observe the myriad spores which will have escaped their spore cases.

OBJECTIVES

The beginning students of biology will be able to appreciate the following facts:

1. Instructive experiments may be done with simple materials found in the home.

2. Molds do not originate from decaying matter, but rather from tiny "seed-like" spores, which themselves, germinate on decaying matter, and aid in that decay.

3. Mold plants are of many varieties just as our higher green plants.

4. The microscope is an essential tool in the understanding of the reproduction and growth of tiny plants.

Success with simple experiments may arouse students to try many others and so maintain an active interest in the science of life.

$25 For Your Experiment. We will pay $25.00 for each experiment involving either laboratory or stereoscopic microscopes accepted by us for future ads like this one. We're looking for unusual experiments suitable for the high school and junior college level. In the event of similar experiments the one bearing the earliest postmark will be used. The ad containing your experiment will bear your by-line. Write in now!

American Optical Company
Instrument Division • Buffalo 15, New York

pe

y mount

lus

X of the
e hyphae
er power
d spore
ore cases

y will be
ts:

lone with
e.

decaying
ed-like"
te on de-
.

es just

ol in the
tion and

ay arouse
maintain
ife.

$25.00 for
ratory or
us for fu-
r unusual
hool and
imilar ex-
postmark
xperiment

npany
New York

WORLD